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edited by Wesley C. Meierhenry

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A Motto for AV Research

> . . . the analysis of the process of audiovisual education does not call for the formulation of special principles; it calls for the application and elaboration of the general laws of human learning. *(Leo Postman, p. 78 of this issue.)*
>
> . . . [This] sentence . . . might well serve as a motto for research upon audiovisual devices. . . . Certainly this is the assumption that has gone into much of the modern work on teaching machines, and it is clear that the study of special films, illustrative material, and demonstrations deserves the same. I believe it likely that the next decade will show a fruition of the psychology of learning into the technology of learning. It is only fair to say that such a development should work both to the advantage of the pure study of learning and to the applied study of training programs and classroom learning. *(James Deese, p. 86 of this issue.)*

Editor's Foreword

WESLEY C. MEIERHENRY

The editor of this special issue of Audiovisual Communication Review *is professor of education and assistant dean of Teachers College, University of Nebraska. Long a member of the AVCR Editorial Board and the DAVI Board of Directors, Wesley C. Meierhenry was also chairman for two years of the DAVI Research Committee. In that period, he headed the committee directing the special grant that the Teaching Film Custodians made to the Research Committee.*

LEARNING THEORY AS A BASIS for more effectively utilizing audiovisual materials has not been given attention until recently, except for a few individuals. Of the pertinent earlier work, Mark A. May has reported research as far back as 1946 on experimental motion pictures designed and produced to permit examination of certain psychological theories (1). Increasingly over the last few years, educators, psychologists, and some AV researchers have been pondering upon how learning theories may be better applied to instruction generally, and to audiovisual materials specifically. Many of their important conclusions are summarized in *Graphic Communication and the Crisis in Education* (3), prepared as a result of conferences held at the Yale University Institute of Human Relations in 1953 and 1954. This book includes an especially significant statement:

> We believe that the greatest advances in graphic communication are likely to come from basic research of a theoretical-analytical type at the pure science level. Completely empirical comparisons of different media in a given situation can yield results which are largely an artifact of unspecified characteristics of the particular representatives of the media which the experimenter happens to use. Such results tell us little about the inherent properties of different means of representation. A better theoretical analysis of how people learn from pictures and words will help us to design more discriminative experiments.

Audiovisual specialists, as a group, have been practical individuals. Some have questioned the value of theory in the solution of day-to-day problems. These, and many other specialists who have been too absorbed by immediate tasks to look into the matter sufficiently, should welcome the kind of illumination this special issue of AVCR seeks to provide. We invite them, at this point, to consider the justifications for adequate theory-building—along with hints for profitable application—that May (2) persuasively presented in 1960 at a Research Seminar supported by the National Defense Education Act, Title VII, Part B:

> First, a well-formulated theory is a fruitful *source of hypotheses* to be tested by observation or experiment. A familiar illustration is provided by any textbook in plane geometry. The theorems to be proved by the students are actually arrived at by logical deduction from a limited number of basic axioms which are definitions and rules for manipulating them. Starting with arbitrary definitions of straight lines, parallel straight lines, and number of degrees on a straight line, it can easily be deduced that the number of degrees in any triangle is 180. This deduction can be checked empirically by actually measuring the angles of a large number of triangles of all shapes and sizes . . . on plane surfaces. . . . Measurements can be repeated until the investigator is convinced that the deduction is actually true to observed facts. . . . The more theorems or hypotheses that can be logically deduced from a set of axioms or postulates that are testable by observation and measurement, the more useful the theory for the advancement of empirical knowledge.
>
> Some theories, however, are so loosely formulated that it is impossible to make rigorous logical deductions from them. They may, however, be very provocative, stimulating, and suggestive of new observations and experiments. An example is Freudian theory of personality and social adjustment. From the standpoint of producing new insights into the underlying mechanisms of human behavior, this theory has been exceedingly stimulating. . . .
>
> A second way by which knowledge is advanced by theory is that of indicating when and where to look, or what experiments are more likely to be fruitful . . . [thus] saving money and effort by cutting down on the amount of sheer trial and error experimentation . . . a great deal of the experimental research in the audiovisual field has been that of trying out almost every conceivable condition that might possibly have some influence on learning from films. If better learning theory relevant to the learning tasks were available, it would be possible to make much better predictions concerning which of several sets of conditions are most likely to influence learning. Furthermore, a good theory should suggest lines of attack which might not otherwise occur to the investigator.
>
> Third, a theory aids in the advancement of knowledge by providing general principles which will comprehend several kinds of facts. The classical example is the discovery by Newton that a falling apple, the swinging of a pendulum, and the orbits of planets and satellites are all instances of the principle of gravitation. In the field of psychology, intense hunger, thirst, pain, cold, blinding lights, and deafening sounds are all instances of primary drive, defined as very intense stimulation. Phenomena that obey the same laws can be comprehended under a single law.
>
> Fourth, theories advance knowledge by serving as convenient devices for communication among scientists. In behavior theory, the important theoretical

concepts such as drive, motivation, reinforcement, expectancy, life space, are generally understood. This technical vocabulary of theoretical terms makes possible more effective communication between psychologists.

Fifth, a theory may advance knowledge by suggesting new techniques of observation, new experimental methods, and new ways of treating data. For example, astronomers have predicted what man would see if he could look at the back side of the moon. This prediction has served to suggest ways by which the back side of the moon can be explored.

The need for careful and systematic theory development seems to the editor more necessary now than ever before because newer types of media combine in varied ways the older and often simpler experiences. For example, the motion picture combining both an audio and visual message no doubt has a more complex impact on the learner than the spoken word alone, the still picture alone, or the silent "moving picture." Whenever multiple variables are combined, an interaction among them is likely, so that the results differ from the results of each variable used singly. Somewhat parallel developments have taken place in other fields, including medicine where new antibiotics are found not to be equally useful for all types of infections. In fact, some antibiotics found highly successful in the destruction of a specific virus also have such deleterious effect on the body generally that their use must be limited or discontinued. Medical science, therefore, now requires much more precise diagnosis before appropriate medication can be prescribed. So far, however, there has been very little speculation in the audiovisual field as to the specific effects of many of the media when used for either general or particular instructional purposes. The reasons for so little careful inquiry and thoughtful effort to obtain better answers are many; among them has certainly been the failure by educators generally, including audiovisual specialists, to be as knowledgeable as they should be about the conditions under which learning may be expected to take place.

That failure was discussed by the Research Committee of the Department of Audiovisual Instruction,[1] meeting at the University of Nebraska in January 1960. At that time, the Committee considered ways to promote more and better research in the audiovisual field. One of the proposals was to develop a special issue of AVCR dealing with theories of learning and their relationship to instructional materials. The idea

[1] Members of this Committee were Wesley C. Meierhenry, chairman; and William H. Allen, Melvin Brodshaug, Jack V. Edling, George Gerbner, Herbert Hite, Charles F. Hoban, Robert W. Kilbourn, Hideya Kumata, A. A. Lumsdaine, John Moldstad, Kenneth Norberg, Murray G. Phillips, Seerley Reid, G. M. Torkelson, Loran C. Twyford, Paul Wendt, Walter Wittich, Anna L. Hyer, Charles Schuller, Lee Cochran, and William Fulton.

was further refined by the Research Committee at the National Meeting of the Department in Cincinnati in 1960.

James Deese, professor of psychology, The Johns Hopkins University, was highly recommended by many educators and psychologists as one who could work with the editor in developing a list of learning tasks that would give some direction and guidance to those invited to prepare papers for this special issue. In addition, Dr. Deese suggested a number of well-known learning theorists as possible contributors; from his list the editor made the final selections. Each was asked to indicate his position as to how learning takes place, and to set forth the implications of this position for instruction and for use of audiovisual materials. The articles they submitted were also reviewed by Dr. Deese before he prepared the final summary indicating some common elements in the theories, some points of differences or conflict, and some new and unique speculations.

The Research Committee hopes that the articles here presented will stimulate many researchers to experiment in such a way as to validate, modify, or reject aspects of the theories. Non-researchers and practitioners will also find this special issue informative and stimulating: Study of the articles should lead to greater confidence in some of their current practices and to greater skepticism about others. Indeed, since progress in education, as in every other field, takes place when all connected with the enterprise combine the greatest amount of pertinent information with the best possible judgments, the articles brought together here should furnish an excellent basis for progress in the educational process.

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Implications of Gestalt Psychology for AV Learning

ABRAHAM S. LUCHINS

Professor of psychology at the University of Miami, Coral Gables, Florida, Abraham S. Luchins is an influential disciple of Max Wertheimer. His predominant concern is for educational processes that lead not to rigid behavior and rote learning but to understanding.

GESTALT PSYCHOLOGISTS do not have a common theory of learning; they differ somewhat on what takes place during learning (*cf.* 4, 10, 27). Rather than discuss these differences and their implications, we shall deal primarily (but not exclusively) with the views of Max Wertheimer, founder of Gestalt psychology, whose lectures on learning and teaching the writer was privileged to attend.

What is common to Gestalt psychologists is their *approach* to research. They hold, for example, that analysis of a phenomenon should be preceded by attempts to grasp its structural features, and that analysis should deal with the natural structural and functional units of the phenomenon in attempts to understand their role and function in the structure. Such an approach is in keeping with what Wertheimer (1,26) called the method "from above" to distinguish it from methods of analysis that he designated as methods "from below": methods that *arbitrarily* cut a phenomenon into parts or elements, and consider that the phenomenon will be understood through study of such parts in isolation. Instead of descriptions based on an "and-summation" of arbitrarily determined elements, the need is for descriptions based on structural understanding that intrinsically relates parts to their context.

Implications for education are clear. Utilizing a method "from

above," let us study school activities in attempts to discover the structural and functional units, and to understand their role. In particular, it is advisable to study, by means of a method "from above," actual situations in which audiovisual devices are used in order to find out the roles they do play, and those they are expected to play.

DOCTRINES OF MAN

It seems to the writer that the three doctrines of man here summarized can serve as useful heuristic devices for presentation of Wertheimer's views on educational procedures. (See 13 for elaboration of these doctrines.)

Homo Volens

Man is basically an emotio-conative creature. His behavior stems from certain blind inner urges. What is on the "outside" of man is "felt" or "seen" either as avenues or obstacles to the gratification of these urges. Man's inner urges constitute his only reality. External situations, as perceived, have no ontal existence, no existence apart from how the person feels about them. There is no objective evidence, no external criteria or situational requirements which the individual can perceive and understand, and which will influence or determine his deciding, judging, and evaluating. Things have meaning only in relation to their possibility of satisfying the organism's urges. Such questions as whether behavior is apt, required, and sensible are usually not asked. If asked, they are likely to be answered in terms of requirements of the inner needs of the organism.

Homo Sapiens

Contrasted to the *homo volens* doctrine is the conception of man as a creature trying to realize the meaning and structure of the world around him. He acts as he does not solely because of inner urges, but also because he is trying to understand what he is, what the world is, and what is his relation to the world. He is a cognitive creature, capable of perceiving, understanding, judging, and deciding on the basis of evidence, between various actions, objects, and people in his environment. He is able to weigh the evidence as given in his cognitive grasp of the situation. He is capable of being sensitive to the requirements of extra-organismic situations. The values and facts he uses in deciding a course of action are not always just idiosyncratically and arbitrarily related to his feelings or need-gratification, but may be rooted in structural features of ob-

jective reality. Man's urges are not the only reality. There are extra-organismic situations, too, with structural features and requirements that can be studied and comprehended (7,24,25). Man's actions are not cut off from the situation in which they take place, but have certain roles and functions in them. Moreover, man is capable of realizing whether an action is apt or not, required or not, arbitrary or not.

Homo Mechanicus

Man is a machine, the inside workings of which are not known. He may be compared with what engineers call a blackbox. The urges of *homo volens* or the cognitions of *homo sapiens* are not considered necessary for an explanation of behavior. Rather than speculate on what takes place *in* man, advocates of this doctrine prefer to deal with the machine's input and output, with stimuli and responses. Learning may be considered as the association of stimulus to response, and teaching as the programming of a computer or robot.

Gestalt Psychologists' Doctrine of Man

The conceptualization of man implied in Wertheimer's lectures on educational procedure is closer to *homo sapiens* than to *homo volens* or *homo mechanicus*. Although man does not always behave as *homo sapiens*, Wertheimer suggests he is capable of so behaving. A theory of human behavior that does not attempt to understand this capability may be ignoring what is essential. Since under certain conditions man may behave as *homo volens*, under other conditions as *homo sapiens*, and under still other conditions as a machine, we need to discover conditions, both internal and external, that maximize or minimize one or another kind of behavior, instead of assuming that man is nothing but one of these models. It is the "nothing but" attitude to which Gestalt psychologists object (7).

In daily life a person may be narrowed down in his behavior so that he acts as if he were driven by an inner motive. He may see objects in his environment primarily as possibilities for gratification. "Blinded by passion," he may not notice characteristics in the object of his desire other than those which fit his desire. A person may be so set on a goal that his cognitive grasp of the situation is narrowed down to what seems relevant to the goal. He may become mechanized by experience so that he acts mechanically, like a robot, with no understanding and little freedom of choice. Moreover, he may behave out of ignorance, misinformation, or because he is compelled to do so by external forces which

hamper his freedom to look and to choose. All these kinds of behavior are examples of what Wertheimer calls "crippled doing." He implies that, except when man is engaged in "crippled doing," his behavior tends to be characterized by curiosity and exploration. He seeks meaning and clarity, and tries to understand the structural features of his environment and its requirements. Man does not want to do things blindly, or to live in a mental fog.

MOTIVATION

Wertheimer is against the idea that the natural state of man is inactivity, and that theories of motivation are needed to account for his activity; that is, to find out what gets man moving. He suggests that the problem is to account for inactivity, for inaction. It is instructive to compare this view of human action with the Aristotelian and the Galilean conceptions of motion and inertia (10).

Motivation Based on Tissue Needs

Certain approaches to motivation are founded on the so-called biogenetic or tissue needs. Such a view may underlie some of the drive-reduction accounts of learning and perhaps such theories as Maslow's (21). It may also be involved in certain generalizations of human motivation drawn from studies of other species. The implicit assumption may be that human needs can be reduced to or understood in terms of certain tissue needs common to all animals.

Gestalt psychologists consider that when theory reduces human behavior to tissue needs, it overlooks certain important, even crucial, characteristics. That is, such needs have meaning as constructs in the context of certain theories, but are not necessarily the actual everyday needs of man. An approach that stresses tissue needs may therefore be dealing with hypothetical entities rather than with the actual needs of particular people in real situations.

Suppose that a human infant at birth were attached to a mechanism that replaced the placenta, and that he continued to be fed and have all his other tissue needs met as they were in the uterus. This body with the structural features of a human being could grow, but it would not develop what are commonly considered human personality and mentality. The requisite for such development is a human environment. To talk about the dynamics of human development in terms of tissue needs is not to talk about the dynamics of human action (nor, for that matter, the action of any other animal), but to talk about the growth of tissue

with its related morphological as well as physiological changes. Another level of analysis is needed to understand the dynamics of human action.

Gestalt psychologists do not deny that there are common features in certain activities of rats and man. But a description which focuses on these similarities may not portray the crucial aspects of either organism's transactions with its environment. To assume, for example, that what is crucial about human behavior and motivation in eating and copulation is revealed by studies of these biologic acts in rats is to overlook that these acts have different roles in a human being's environment than in a rat's. Gestalt psychologists remind us that behavior takes place in a context, and that attempts to understand behavior should take into account both the context and the role of behavior in that context. They do not deny that an approach via tissue needs in other species may reveal some important factors that are actually operative in human behavior. But to know whether or not particular factors are relevant to human behavior, we have to see them in their proper role and function in particular behavior. That is, we have to *discover* their relevance—not assume at the outset that a factor operative in one species or in one context is necessarily operative in the same way in another species or context.

Motivation in Terms of Ego Needs

Some accounts of human motivation center on ego needs rather than on tissue needs. Gestalt psychologists have paid considerable attention to the ego and to the forces it engenders (4,6,7,11,16,26). They recognize that attitudes, assumptions, expectations, and other such ego-factors are, at times, important determinants of behavior. They point out, however, the necessity to study the roles of ego-factors in concrete situations. To categorize behavior on the basis of the ego, ego-factors, or ego-needs cannot take the place of investigating actual behavior.

As with tissue needs, so with ego-needs, Gestalt psychologists ask for a study of the actual transactions between the individual and his environment. They ask for the study of actual behavior, using a method "from above," rather than *a priori* judgments that behavior manifests nothing but tissue needs or ego-needs, or any other arbitrary combination of needs or motives.

Gestalt psychologists do not offer another set of needs or motives to replace tissue or ego needs. Instead, they suggest that we suspend our biases regarding what brings behavior about, and investigate behavior

in everyday life situations. We should not cut up a particular act of behavior into hypothetical needs, motives, goals, and responses. We should first try to grasp the structural feature of an act. Also, rather than project hypothetical motives and needs into human behavior, let us find out what people themselves state to be their motives and needs. There is a need for a taxonomy of the needs of men as expressed in their everyday language.

Discussions of motivation in terms of the ego often assume that the person behaves as if his ego were the center of the system of coordinates from which he views and reacts to the world. Gestalt psychologists have challenged this view as too sweeping a generalization. Granting that there are people who tend to be egocentric in nearly every situation, and that there are situations in which nearly every person tends to be egocentric, they point out cases where the ego does not serve as the center of the perceptual or behavioral coordinate system (16). In them, forces other than those generated by the ego seem to be the main determinants of what the person perceives and of how he behaves. In other instances, behavior is determined by situational factors or by so-called field factors (26). To understand behavior, it is *not* sufficient to focus on the needs or motives (actual or theoretical) of the person *qua* person. The situation, too, may have requirements. Forces that instigate and help shape behavior may originate outside of the organism. These forces may require one kind of action rather than another. To comprehend an act of behavior, we should be concerned with the requirements of the field in which the act takes place, rather than to assume that *only* organismic determinants are involved. (See 7,24 for elaboration of these points.)

Are AV Devices Primarily Motivational?

One cannot logically deduce an answer to this question from Gestalt psychology. Instead, Gestalt psychology suggests that to answer the question we have to know what role and function particular audiovisual devices have in particular learning situations. There is a need to survey what kind of devices are used; where, when, and why they are used. What are the reasons for using one rather than another audiovisual device, and for using it in one manner rather than in another, or for introducing it at one point in the lesson rather than at another point? What is the basis for selecting and utilizing audiovisual devices? Do the selection and utilization seem to be influenced by the subject matter, by the personality and training of the teacher, by the school administration, by the social atmosphere of the school and community, or by an

educational philosophy or policy? What do teachers state as their reasons for using audiovisual devices? Do they use them to arouse interest or to maintain it, to entertain, to illustrate, to save time, to provide busy work? Or to allow children to engage in self-instruction, proceeding at their own pace—that is, to provide for individual differences? Or for other reasons? Do they use different kinds of audiovisual devices for different subjects, for different grade levels? What are considered the *ideal* functions of audiovisual devices, and what are their *actual* functions in learning situations? Such questions should be asked not only of teachers, but also of administrators, AV consultants, professors of education, and pupils.

Focusing on a specific device, let us find out the purpose for which it was devised, as well as the conceptions of its purpose as expressed by teachers and pupils who use it. How do these conceptions compare with one another? How does the intended purpose compare with its actual accomplishment in a specific situation? How does the role of the device compare when used by different teachers in different social contexts? Even though the same audiovisual device is used by different teachers in the same way, the transaction between device and pupil may differ among pupils and social environments. We need to know more about the actual transactions that take place between teacher, pupil, and AV device. We need to explore how to structure or to organize a particular learning situation so that audiovisual devices accomplish their intended purposes and help move the learning in the desired direction.

With reference to a specific audiovisual device in a specific learning situation, certain questions should be asked: Is it necessary? Apt? Suitable for the teacher, the requirements of the subject matter, and the needs of the pupils? To think of audiovisual devices mainly in terms of the last—the needs of the child—may be unduly restrictive.

Admittedly, the educational process is directed to develop certain knowledge and skills. To the extent that audiovisual devices help achieve this goal, they may be regarded as intrinsic to it. To the extent that the device is intended primarily to arouse interest, or to entertain or reward the pupil, it may be regarded as extrinsic to the goal. Moreover, to the extent that the device is based on the structural features of the subject matter, it may be regarded as intrinsic; to the extent that it is unrelated to—or only peripherally related to—the subject of the lesson, it may be regarded as extrinsic.

Audiovisual devices are often based primarily on extrinsic rather than intrinsic motivation. The teacher may hope that the child will eventually develop an interest in the subject matter or in the learning task *per se*. We may get a child to go to Sunday school by giving him candy, but we do not want him to keep on going merely for the sake of the candy. The candy is used to attract his attention; after that, we hope to develop an interest in religion. Similarly, with school subjects we use extrinsic motivation to capture the pupil's attention. But too often we use it to the exclusion of intrinsic motivation. This restriction may be due to a number of factors. Intrinsic motivation may not be regarded as feasible due to the cognitive grasp of the teacher and/or students. Because of certain theoretical convictions, teachers may regard extrinsic motivation, such as rewards, the most effective way to bring about learning.

There are dangers involved in using audiovisual devices solely or primarily for extrinsic motivation. The pupil so motivated does not come to grips with the subject matter. He may develop a superficial relation to the subject matter in question, and even to learning in general. He may, for example, work for such extrinsic reasons as rewards, status, avoidance of punishment. He may come to view all learning in terms of its entertainment value. Thus, the conception of what constitutes learning may be influenced by the kind of motivation.

It is important that audiovisual devices should not become merely a means of entertainment, of developing superficial familiarity with the subject matter, or of making learning a passive activity. They can be vital instruments to elucidate and clarify ideas and concepts, and to bring about a search for insight into structural relationships of the concepts and skills being taught.

How Can Audiovisual Devices Capitalize on Existing Motives?

If we take into account both the *homo volens* and *homo sapiens* doctrines, then we should ask not only how audiovisual devices can capitalize on the motives of *homo volens*, but also on the needs of *homo sapiens*. Aside from appealing to an individual's likes or status or appetites, audiovisual devices should appeal to his need for cognitive clarity and meaning, and should challenge his curiosity and decision-making ability. We should not overlook the possibility that a person may want to learn and to understand, and may not be satisfied with easy and entertaining activities.

It may be asked of an audiovisual device: does it focus mainly on the *homo volens* type of motives or does it "open the eyes," challenge thinking and curiosity, help reveal intrinsic structural properties of the subject matter, and make it easier to understand? There is a need to develop more audiovisual devices that reveal the structure of the subject matter. (For examples of those that may help to do so, see 23,26.) The development of such devices is not easy. It involves the problem of how to study and analyze the structure of what is taught. Moreover, it poses the problem of how to pace the presentation of the lesson, and the particular audiovisual device so that pupils grasp the structure of the concept or procedure being taught.

Since a Gestalt may extend beyond itself, it is important to study not only the learning process but also the social climate in which the learning takes place. The possible influence of the AV device on the social climate, and vice versa, should be considered. Some devices may seem structurally clearer than others, but it may not be advisable to use them because they may create a social climate that interferes with learning. For example, in lessons intended to teach Arabs the value of a balanced diet, it is not advisable to use an AV device which refers to pork. That reference is likely to arouse attitudes that interfere with their grasping the essential point. To avoid such disturbing factors, it is necessary to take into account not only the social norms of the pupil's status groups but also his reference groups. (See 22 for a discussion of such groups.) Also, it may be advisable to take into account the meaning of audiovisual devices in terms of the life experiences and feelings of the learner. But it should not be forgotten that the devices should also be meaningful in terms of the structure of the subject matter. For example, in an arithmetic device, the problem of whether the items involved should be dots, colored squares, birds, or pieces of candy may be less important than how the items should be grouped. One grouping may reveal the structure of the arithmetical operations far more adequately than another. Care should be taken not to divide the subject matter into arbitrary parts, contrastructurally, in order to have parts which can be readily related to the pupil's needs, or feelings, or experiences or to the social context.

Is any special personality type more apt to profit from AV?

Some pupils are closer to the *homo sapiens* model than others. Some tend to be more egocentric, and some more field-centered. These differences may call for different AV devices to insure optimum effectiveness.

There is also the issue of whether methods can be developed to help ego-centered pupils become more field-oriented. Moreover, does a focus on *homo volens* tend to change field-centered pupils into ego-centered individuals?

Is it possible to "tailor" audiovisual material to increase motivation?

It is not only possible, but it may also be necessary. Some AV devices operate on theoretical conceptions of children's likes and interests to the neglect of actual attitudes and assumptions. Knowledge of pupils' actual attitudes, along with knowledge of the structure of the subject matter and intended purpose of the audiovisual device may yield bases for attempted tailoring. A device suitable for one type of subject matter may not be at all adequate for another because, although it is in keeping with and helps reveal the structure of the former, it may be out of keeping or irrelevant to the structure of the latter. Similarly, a device suitable for one group or one social climate may be unsuitable for another.

The problem of "tailoring" audiovisual devices is intimately related to their purposes. Are the devices being used to entertain, to attract attention initially, to drill, to give a specific model to be copied, to clarify an idea, to provoke curiosity, or to reveal structure? Different devices may be needed for different purposes, or a given device may have to be tailored or used somewhat differently to serve different functions. The ability to tailor audiovisual devices perhaps calls for a sensitivity akin to that of clinical acumen or to a creative mathematician's knack for problem solution.

RESPONSE

Gestalt psychologists oppose associationistic conceptions of learning when they are presented as *the* prototype of all learning, but they do not deny that such learning takes place (2,4,9,11). That is, they regard the problem of what is learned as a problem with "non-unique" solutions. They hold that not all conceptualizations are equally adequate to explain what takes place in learning situations. Theories of learning involve diverse approaches to control of the teaching-learning situation. These differences have important implications for practice. This report deals with the practical rather than with the theoretical implications and issues. (The latter are discussed in 2,3,4,5,6.)

Again using the doctrines of man as a vehicle for discussion, we may say that Gestalt psychologists are concerned with characteristics of

homo sapiens. Associationistic theories, according to Wertheimer, do not deal adequately with such characteristics; they seem to espouse the *homo mechanicus* doctrine that views man as a machine.

What Should Pupils Learn?

Gestalt psychology suggests not so much *what* pupils should learn but *how* they should learn. It is concerned not only with responses, but also with the processes that lead to responses. The same responses may be brought about by different processes; different responses may be brought about by the same process. In particular, the same overt response may result from a process of understanding involving organization and insight into structure as from a process of memorization in which stimulus and response are arbitrarily connected. However, consequences of learning through understanding and organization seem to differ from the consequences of learning through memorization (2, 11, 19, 26). Some of these differences will be considered in the sections on practice and interference.

Can learning be characterized in terms of specific responses or should something "more general" be learned? The answer may depend on whether one is committed to the *homo sapiens* or *homo mechanicus* model of man. Those committed to the *homo sapiens* doctrine are concerned not merely with the overt responses, but also with the process that led to the response. They hold that a person has learned when he has grasped or understood the structure of a concept or procedure. It is not important that he repeat exactly the specific response that was demonstrated, but that he indicate understanding of, or insight into, the role and function of the particular response in the structure of which it is a part. In the *homo mechanicus* model, understanding or grasping of structure is not crucial; what matters is that the learner make the specific responses that were demonstrated.

In analyzing the process that led to the response, one should take care to see whether the pupil really understood what he was doing, or whether he repeated mechanically, or stumbled upon the response. A pupil may repeat demonstrated responses correctly and yet not get the point; on the other hand, he may repeat incorrectly and yet grasp the point. Errors in response may not indicate errors in the process. In arithmetic, for example, the correct procedure may be used intelligently, but a mistake in calculation produces the wrong response. A distinction has to be made between "senseless" and "sensible" errors; the latter

give hints that may help restructure the learner's cognitive grasp of the problem so that afterwards he can deal with it more adequately. Moreover, processes that lead to the same response may not be equally good. For example, one may use a roundabout, "ugly" procedure and be blind to simpler, more direct, or more "elegant" procedures. (See 4,5, 11,26 for detailed discussions of these points.)

Emphasis on specific responses, of course, has one advantage: it may result in ready and accurate responses which assist in the development of efficient habits for recurring life situations. But, as we shall see, the individual so taught may become mechanized (11,19).

What special techniques make a difference?

If education should enhance *homo sapiens* characteristics, then provision should be made in audiovisual learning for analysis of process. This calls for an examination of AV devices to find out whether they are concerned primarily with overt responses, or whether they adequately provide for analysis of the processes leading to the responses. Is provision made in AV learning for distinguishing between learning by understanding or organization, and learning by memorization? For distinguishing between "senseless" errors and "sensible" errors?

It is our impression from examining workbooks, teaching machines, and other self-instructional devices that often the predominant concern is with overt responses, rather than with processes. The pupil practices certain responses that may be the result of arbitrary division of subject matter, cut up in a contrastructural manner. He is afforded little opportunity to view the total structure, or to understand the function of a particular stimulus or response in the structure from which it is derived. Since the device gives the learner bits of information in a step-wise fashion, he tends to learn them only in a piece-wise and "summative" manner. Also, since the stress in audiovisual learning is on the overt response, he tends to be concerned with this rather than with the process that leads to it.

The method of testing or evaluation may also influence what and how one learns (17). The emphasis on specific responses in examination, particularly in the objective tests, focuses the individual on them. If specific responses are what count, the individual may set them as his sole goal. Teachers may even seek to maximize efficiency in reproduction of responses so that the class may make out well on the "achievement tests."

Thus, the method of teaching and its evaluation may affect the conception the student has of the educational process, and of his relationship to the teacher and the subject matter. In teaching based on the *homo mechanicus* doctrine, the pupil may conceive of learning as repeating exactly what the teacher said or what is in the textbook. Learning is regarded as a reproductive rather than a productive activity (2).

Admittedly it is not an easy task to develop audiovisual devices that stress process and reveal structure. But it must be done, if teachers do not wish to use AV devices primarily for exercise, drill, or mechanized response.

There is nothing in Gestalt theory which says that one must not emphasize specific responses. A scientific theory cannot dictate the aims of education or the kind of audiovisual material to be used. But if public policy considers the purpose of education to be the maximizing of *homo sapiens* characteristics, then designers and users of audiovisual material should face the challenge of creating devices that contribute to the development, maintenance, and enhancement of such characteristics.

INTERFERENCE

Interference Between Audiovisual Learning and Ordinary Learning

What kind of device brings about interference, what is the nature of the interference, how is its existence determined, who feels it to be interference (the teacher or the pupils), what is the direction of the interference, and in what kinds of situations does it arise? These are research problems, some of which are related to problems raised in the section on motivation.

Interference may be an artifact of the whole audiovisual device or of aspects of it. It may be due to when, where, and how the aid is introduced in the particular learning situation. It may be a result of the kind of relationship that develops between the particular device and (a) cultural factors, (b) the social atmosphere of the classroom, (c) the structure of the specific teacher-learning process, (d) the structure of the subject matter, and (e) the personalities of the learner and the teacher. Whether or not interference results may be determined in part by the attitudes and assumptions of the pupil to the specific audiovisual device, to similar devices, or to audiovisual devices in general, which in turn may be affected by his previous experience.

Can interference lead pupils to emphasize the "wrong things"?

Interference may, indeed, occur because the AV device stresses the "wrong thing." What the device presents may go in a direction different from the goal of the particular lesson. The device may introduce extraneous ideas or concepts that deflect the learner from the lesson's goal and substitute another goal. Interference may occur because the organization of the material in the audiovisual device is contrastructural to the natural organization of subject matter as a whole, or to the structure of the particular concept or procedure being taught. Interference may occur when the relation of the audiovisual device to the teaching-learning process is akin to the relationship of irrelevant jokes in a speech.

As suggested in the section on motivation, some educators think that the best way to give "functional meaning" to material is to relate it to the past experience, needs, and interests of the learner. But there is another sense of "functional meaning": the meaning that a part of a constellation has because of its role and function in the whole structure. In using audiovisual devices, we should be wary of obscuring such structural meaning in attempts to relate the material to the students' needs, interests and past experiences. Such a relationship may not necessarily help the learner to grasp or understand the concept or procedure; it might focus attention on factors unrelated to and extrinsic to the structure, and thereby interfere with learning.

Interference may result from attempts to make the subject more meaningful through the introduction of meanings that are extrinsic to the subject matter's inherent structure. For example, a well-known educational film anthropomorphized various heavenly bodies and cosmic rays. A child with some understanding of science may grasp the mystery and excitement that underlies cosmic phenomena in the film. But other children may come away with a belief that the cosmos is inhabited by "little Fagins," the Dicksonian film characters that portrayed cosmic rays. Similarly, a book on mathematics that introduces trigonometric functions as Mister Sine, Mister Cosine, etc., may be amusing and even helpful to someone who has some previous understanding of trigonometry, but quite confusing to one who lacks it. Moreover, some "literal-minded" children object to such examples as untrue or silly. The child has to be willing to entertain (and be entertained by) the anthropomorphizing, and yet not accept it as a reality. He has to know something about the subject matter in order to appreciate the point of the anthropomorphizing, and to know where the subject matter ends and the an-

thropomorphizing begins. Generally, in this type of popularizing, there is some danger that the audiovisual material will be confounded with the actual material to be learned.

Some AV devices are mnemonic, and some learners confuse them, too, with the actual subject matter. The reader may know the poem about the little girl who, in order to memorize the answer to a number combination, associated it with her doll's name. When the teacher presented the number combination, she called out her doll's name. In the author's college teaching experience, he has come across students who, much like the little girl, resp ded to examination questions with irrelevant ideas associated with me books, films, TV shows, and even the lecturer's audiovisual devices.

Can AV learning produce negative transfer?

An AV device can introduce interference in the sense that it fosters a mental set, or *Einstellung*. The device may set the child to think in a certain direction, and he may continue in this direction even when the situation changes and requires a shift in orientation (19). The device may provide the child with a model (that is, a method of solving problems of a certain type) which he may apply mechanically to subsequent situations that he considers to belong to this type. Such negative transfer will be considered further in the section on practice.

How can interference be avoided?

Interference, including negative transfer, may be diminished and positive transfer facilitated if learning is a process of organization and understanding rather than of memorization. If a pupil gains insight into the structure of a procedure or concept, he might be expected to recognize the structure even when certain elements are changed; thus insight enhances the likelihood of positive transfer. If the pupil understands the relationship of a response to the context in which it is made, he is less likely to make the response in inappropriate contexts, and more likely to make it in appropriate ones. If the concern in teaching is with the aptness of a response, the learner might be led to consider what response is apt and fitting, rather than unthinkingly making an inept response, as is sometimes the case in negative transfer. Indeed, one method of ascertaining whether or not learning infused with insight has occurred is to study the extent of negative and positive transfer in certain situations (11, 19, 26).

It should not be assumed that an audiovisual device necessarily inter-

feres with learning because it creates tensions, anxiety, frustration, or controversy, or because it unstructures the learner's frame of reference. The assumption may stem from the dictum of some psychologists that frustrating experiences should be avoided in learning. Teaching procedures are sometimes judged as inadequate if they arouse tensions, and may even be rejected because they might possibly create tensions. Indeed, attempts may be made to "clean up" teaching procedures so that they do not arouse tensions. Yet, there is research evidence that not all tensions interfere with learning, and that a moderate degree of frustration and anxiety may be more conducive to effective learning than a very low degree (19). In this connection, it is interesting to consider a distinction that Wertheimer made between two kinds of tensions. By tensions spelled with a small *t*, he referred to the forces in the dynamics involved in the organism's maintaining itself and achieving its goals in a particular *situation*. He designated as Tensions with a capital *T*, forces that interfere with the organism's achieving its own *particular goals*. In the teaching-learning situation, we should therefore distinguish between tensions that are due to forces leading to productive achievement such as grasping and understanding what is being taught, and Tensions that interfere with such achievements. The same overt anxiety may be due to different processes, and has to be judged in terms of the processes and its accomplishments. (See 19 for the role of anxiety in problem solving.)

It follows that audiovisual devices should be used to create *tensions but not Tensions*. Audiovisual devices may also be used to shock the learner, to unstructure his frame of reference, to make him aware of contradictions and controversies, and so on. In short, audiovisual devices may be used as eye-openers rather than as tranquilizers. Gestalt-oriented research suggests that the creation of certain attitudes and social atmospheres in the classroom may help to mitigate against Tensions and set the stage for tensions. Such setting of the stage is important for a teacher who is going to use audiovisual devices as eye-openers.

PRACTICE

Gestalt psychologists do not consider that practice or repetition is a necessary condition for learning (4). Nor do they consider that all learning is through insight, and that past experience *never* plays a role in learning or that insight is always *sudden* in nature. They have pointed out that insight can occur in the first experience, that it may not occur

until a later experience, and that it may not occur at all (4,5).

Such phrases as "learning through practice" or "learning through repetition" have been applied to learning situations where the objective is to have a response repeated over and over again, with as little variation as possible. The phrases have also been applied to situations where certain variations in response are the objectives of the practice. This is the intent of the expressions that practice makes for improvement or that "practice makes perfect." It is a question, then, of how we view what takes place during practice. Are we concerned only with the number of times that an individual makes or does not make a specific response, or also with what happens to the pattern of behavior during practice? Wertheimer suggested that we should study the whole behavior during practice—such factors as changes in the structure of the behavior, including the relationship of the learner to the teaching situation. For example, is there a change in the nature of errors from "senseless" to more "sensible" ones? In short, what happens during practice should be viewed with reference to what remains invariant from trial to trial, with reference to increase of the probability of certain responses, and with reference to various changes in the nature and pattern of behavior throughout the course of practice.

Education which views repetition without variation as the paradigm of learning is not education in the sense of the *homo sapiens* doctrine, although it may be in the sense of *homo mechanicus*. In the former, education is concerned with developing minds; in the latter, it programs robots. If the emphasis is on practice of peripheral details, the learner may develop a piecemeal approach to reality; with the concentric narrowing of his visual and cognitive field, he overlooks important features of the constellation of stimuli or events before him, or even is blinded altogether to structure. The danger of education which focuses on sheer repetition is that it makes little provision for, and perhaps may even destroy, the desire for understanding and the display of curiosity, imagination, and creativity.

Is Practice Important in Audiovisual Devices?

For learning that includes gained insight, the amount of practice and the number of repetitions may be less important than the structure of the subject matter. Rather than being concerned with how much repetition is needed, Gestalt psychologists would be more concerned with which constellations of stimuli are easier or more difficult to learn, and

with the factors that contribute to the ease or difficulty of learning. Therefore, the opportunities an audiovisual device offers for practice might be considered less important than whether it reveals the nature of the material to be learned.

Nonetheless, Gestalt psychology does not deny the value of practice for fixating responses. It recognizes that even mechanical habits are of value in meeting recurring situations in life if they are appropriately applied (11,19). When the aim of practice is to inculcate a specific response, it may be crucial to consider how much practice an audiovisual device affords. But Gestalt psychologists consider that practice can have other aims. For example, it may help the learner to maturate the structure of the procedure or concept being taught, and also may help him to individuate its functional parts so that he sees them in their proper role in the structure. When practice has such aims, then the *amount* of practice an audiovisual device affords is less important than the *kind* of practice it provides.

How Can Practice Be Integrated in AV Learning?

To integrate practice in audiovisual learning, as in any learning, it is useful to have the pupil understand *what* he is practicing and *why* he is practicing it in a particular context. Individuals, Wertheimer points out, need to get a good structure—a sensible relationship—with the material with which they are dealing. Forcing a child to repeat a response which is senseless to him may weaken and even destroy his ability to develop such sensible relationships. If he is forced to reproduce exactly what was shown by the teacher or the textbook or the audiovisual device, if all deviations equally constitute errors, then he may cease to explore the problem; he may stop trying to grasp the structure and meaning of the material, or to understand the relationship between the material and his response.

Certain disadvantages of learning through practice or repetition have been investigated by the author for over two decades (11, 19). Of particular interest has been the so-called *Einstellung* phenomenon in which subjects who learn a response through repeating it in a series of similar situations, tend to repeat it mechanically in subsequent situations calling for more adequate solutions; they even tend to adhere to it when it is altogether inappropriate. This phenomenon seems to hold for perception, motor behavior, concept formation, and problem solving of various kinds. Information that has been obtained concerning condi-

tions that tend to maximize or minimize this *Einstellung* phenomenon may be relevant to AV devices, particularly in the successive presentation of information by teaching machines, in workbooks, films, and recordings. (See 19 for detailed suggestions on what may be done to prevent the development of an *Einstellung*.)

Whether or not an individual shows *Einstellung* effect depends in part on how he learned the response. Our findings suggest that such effects are fostered by drill in the initial learning period. Once a response or procedure has been presented in a meaningful manner, drill in it may not be as disadvantageous. To the extent that these findings can be generalized for audiovisual devices, they suggest that devices which offer *"isolated drill"* should be avoided in the *initial learning period.*

Moreover, audiovisual devices themselves can serve to cut down on mechanization by dramatically illustrating the dangers of blindly repeating what is learned. This can be done in arithmetic by introducing a solvable problem similar in appearance to one that has just been taught, but which cannot be solved by the same method. After the pupils have attempted to work on the problem, the teacher may discuss with them their explanations for failing.

Audiovisual devices may present examples with different content than the material presented in the lesson, but in which the same principle is applicable. They can give the children either direct experience with such problems, or vicarious experience—by presenting a demonstration of such a problem being solved by others. Then the class discusses it. Thus, audiovisual devices can be used not only for practice of a response, but also for teaching about its range of application and the dangers of inappropriate application.

Research on *Einstellung* effects revealed that mechanization decreased, and solutions of original problems increased, when subjects were given more opportunities to participate actively in problem solving, in the sense of making necessary decisions. This finding illustrates the importance of active problem solving in contrast to passive practice, and raises the question to be considered in the next section: What opportunities do pupils now have for decision-making in audiovisual learning, and what can be done to increase them?

REASONING

Importance of Active Attempts at Problem Solving

There are two issues involved here: (a) the importance of audiovisual learning in problem solving; and (b) the importance of problem

solving in audiovisual learning. Views on each of these issues are related to the objectives of education in general, and of the particular lesson. Concerned with *homo sapiens* characteristics, most Gestalt psychologists would say there should be provision for problem solving in AV learning. If such provision is not made, there is the danger that audiovisual learning may interfere with the drive in man not to be blind, not to be satisfied with superficialities, not to meet things halfway, or indirectly, or deviously—the drive to get rid of mere summations of items and to get at structure, to meet the requirements of situations, and to think productively (26).

Since educators presumably are concerned with *homo sapiens* characteristics, research is needed to find out why, where, and when audiovisual learning provides or does not provide for productive thinking. What is the influence on productive thinking of the way in which the material is organized, the way the devices are used by the teachers, the kind of pupils they are used with, and the attitudes and conceptions of teachers and pupils toward the particular audiovisual material? Moreover, what are the conditions that maximize problem solving in audiovisual learning?

Many classroom activities do not involve active participation in problem solving. Frequently the problems presented do not arouse tensions for solution—partly because of the small time-gap between the presentation of the problem and the presentation of the solution. Pupils have little time to search for solutions. Nor are they encouraged to search. A passive attitude is fostered and pupils just wait for the solution to be presented. Among other factors that may discourage active participation in problem solving is extrinsic motivation, which we have already discussed.

Still another factor is the insufficient attention that our teaching and textbooks give to problems with more than one solution, to problems with no solution, to those that have not yet been solved but may be solvable, to those that have been proved to be unsolvable (such as the problem of trisecting a general angle under the classical restriction to compass and straight edge), and to propositions that can neither be proved nor disproved by methods of the formal system of which the proposition is a part (as in Gödel's incompletability theorems). The intent here is not to introduce higher mathematics in elementary schools (although experiments indicate that with suitable teaching and well-utilized audiovisual devices this too can be done, at least for intuitive

mathematics). The intent is to help pupils realize that there is no neat one-to-one correspondence between problems and solutions. Because problems of everyday life belie such a correspondence, it is important for pupils to realize that reasoning does not always lead to a solution; that it may lead to no solution, or to the conclusion that there is no solution; that different processes may yield the same solution—as different routes may lead to the goal in a maze—with some solutions preferable for certain purposes. Students need to be alerted to all such possibilities. Also they should be made more aware of the influence, on the solvability of a problem, of admissibility conditions—those that are implicitly or explicitly stipulated as conditions the solution must meet.

Also relevant here is the relationship between the hypotheses of the problem and its solution. Classroom problems tend to give those and only those hypotheses ("givens") that are used in the solution. Yet in problems of daily life and the sciences, the problem solver often has to select hypotheses, discard those that are superfluous, and decide when the hypotheses are insufficient for solution. Teaching should give more attention to such matters (and not only in algebra courses) in order to encourage active problem solving.

Audiovisual devices may help to reveal the varieties of structures of problems in relation to the number and kinds of solutions they possess, in relation to admissibility conditions on solutions, and in relation to whether the hypotheses are insufficient or superfluous for solution.

How else may AV stimulate systematic thinking?

Research is needed on the role and function of audiovisual devices in learning situations that attempt to stimulate reasoning. In such situations audiovisual devices conceivably can: illustrate clear-cut structures as well as various degrees of structurization; present hints as to the next step in proceeding; pace the learning; illustrate required elements; point to gaps in the learning process; and illustrate sensible, productive ways of dealing with a particular task in contrast to stupid ways.

How do teachers help stimulate reasoning and concept attainment?

The teacher can play an important role in stimulating reasoning. He may do so by presenting clear-cut examples of good thinking or, contrariwise, striking examples of poor thinking. Similarly, he may aid concept attainment by illustrations of cases that fit or do not fit the concept.

The teacher can use audiovisual devices to provide hints toward solutions, and to remove sources of confusion during the course of

problem solving. At times, however, it may be advisable to use audiovisual devices deliberately to confuse; that is, to unstructure a student's viewpoint by providing striking contradictions to his ideas. In this manner audiovisual devices may operate against "premature closure" in thinking.

Research is needed on the relationship between teachers' effectiveness in stimulating thinking and their conceptions of their roles. Do teachers who regard stimulation of reasoning as an important aspect of their roles tend to use audiovisual devices to engage the children in active problem solving more often and more effectively than do teachers who conceive their roles to be that of inculcators of specific responses?

The following suggestions as to what the teacher can do to stimulate reasoning and concept attainment are *not* logical deductions from Gestalt psychology, but are based on the manner in which Max Wertheimer and the writer have sought to achieve such objectives.

It is not the quantity but the quality of illustrations that matters. One clear and dramatic example is worth many mediocre illustrations. Moreover, the same audiovisual device may be used for various purposes during the same or different lessons if it is structurally suitable.

The teacher has to realize when to use an audiovisual device that presents a complete idea, and when to use one that only hints at an idea. It is of value at times to use an illustration that does not put across "the point" to passive spectators but instead requires that the students work to get the point. Illustrations might raise a problem without presenting its solutions; that is, through dramatic examples raise tensions in the viewers, or at least make them realize that a problem exists. (Wertheimer once said that to realize that a problem exists may sometimes be as important as to achieve its solution.) Thereafter, through questions and hints, the teacher prods the student to think further about the problem or concept. Through properly paced hints, students may be led to discover solutions.

The reason for an illustration need not be immediately apparent. Wertheimer frequently aroused his students' curiosity through audiovisual material which seemed quite unrelated to the topic at hand. After the class had discussed the effect of the audiovisual device on them, Wertheimer related it to the topic at hand, or asked the class to discuss how the device (a demonstration or a slide) might be relevant to the present or preceding lectures. In short, an audiovisual device does not always need a build-up, although sometimes a build-up is desirable.

It is often of value to obtain students' reactions to an illustration. These may be obtained from observations or from asking them such questions as, "Why do you think this illustration was used?" The students' answers may indicate the role and function of the audiovisual device in the lesson, and may serve as bases for deciding whether a device should be continued, altered, or replaced.

Audiovisual devices should be used not as inflexible parts of a formal lesson but in relation to the objectives of the lesson, and the extent to which they are being achieved. The teacher should be prepared to accelerate or delay presentation of a device if this seems advisable. Indeed, he should decide not to use a device called for by the formal lesson plan if he notes that the pupils already understand the point the device would illustrate. It may seem advisable in a given lesson to interrupt the presentation of the audiovisual material—even though it had been originally developed for a continuous presentation—and to resume it only after a discussion, or perhaps not to resume it at all. It may also be best to use only part of a certain audiovisual device. There is no inherent reason why presentation of audiovisual material cannot be stopped at various times, why a whole film has to be shown, or a whole recording played, or all of a diagram discussed, once it is introduced. The teacher may present part of a film or recording, and wait to see what develops. Or he may ask the students to predict what will be next in the audiovisual device. When the next part is presented, the teacher may discuss with the class reasons for success and failure in their predictions. Pupils may thus learn what factors interfered with their grasping the theme or point of the device.

In order for the teacher to stimulate reasoning and concept attainment, it is advisable for him to understand well the concepts involved in the lesson. This calls for audiovisual material to help teachers gain insight. Such audiovisual material may differ from the audiovisual devices teachers use in the presentation of the same concepts to pupils. For example, the *Continental Classroom Mathematics Program* on TV has shown some audiovisual devices which help teachers to attain the concepts (particularly in the sessions intended primarily for teachers), and other devices that teachers can use to help their students attain the concepts. This does not mean that the audiovisual department has to grind out devices for teachers in addition to devices for pupils. Teachers should be encouraged to create good examples for particular concepts, and to consult with the audiovisual department to develop devices that

fit the particular teaching-learning situation rather than to regard the audiovisual department as just a transmission belt for the manufacturers of audiovisual material.

The teacher can play an important role in selecting devices, in adapting existing devices to the needs of the particular class and particular lesson, and in devising new ones. Although ready-made and technically perfect devices are useful, there are values in simple devices improvised on the spot when the teacher senses that a particular point needs clarification. It is sometimes advisable to supplement (and in some cases to replace) ready-made devices with improvised illustrations that are contextually more suitable, even though technically inferior.

Finally, pupils can also participate in the development of audiovisual material. For example, they may be asked how they would change an illustration that was used or what other device they would suggest. This is a procedure that the writer has used in teaching elementary, secondary, and college courses. Students at times were told, "Suppose you had to explain to someone (say, a child not in this class) what you have learned. What would you show him in order to help him to understand? For example, what picture, illustration, or story would you use?" Such procedures allow for self-involvement of the learner in altering or improvising audiovisual devices. Moreover, they give the pupil experience in communicating his ideas and in seeing differences between learning and communication, as well as between impression and expression. In this way, too, audiovisual devices may become an integral part of the lesson.

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. . . look for improved methods

Teaching procedures, including graphic devices, can be improved when we make certain by research that students are actually learning what they are supposed to learn. What are the specific kinds of behavior we want to produce? When we start testing for these habits and find we are not producing them, we begin to look forward for improved methods.

It is easy to get the machinery ahead of the objective—to divorce one's thinking from the instructional objective and believe that there is some magic in mere technique. One can do this with the textbook, the lecture, the film, television, or any technique. The better approach is to try to locate the fundamental educational problems . . . and then to see how new techniques can help to solve them.

From *Graphic Communication and the Crisis in Education*, by Neal E. Miller and others. (Reprint of *Audiovisual Communication Review*, Vol. 5, No. 3.) Washington, D. C.: Department of Audiovisual Instruction, National Education Association, 1957. p. 32.

. . . differentials in learning

Here are some of the areas in which I believe understanding of the learning process and the learner can make a contribution. First, there is a body of information concerning the differential nature of the growth of the individual. This growth differential is typical not only of the obvious physical attributes of individuals but also of their emotional and intellectual ones. Information about maturation and growth has obvious implications for the grade placement of instructional materials and for the assessment of the appropriateness of various methodologies. . . .

A second element of knowledge concerning the learner and the learning process is that of the differential natures of abilities. The knowledge that people differ in such primary mental abilities as memory, verbal fluency, spatial manipulation, numerical reasoning, etc., is basic to the concept of *grouping* of students. . . .

Differentials in the modes of reinforcement of learning constitute a third area of knowledge which is a vital element in the educational foundation of the general audiovisual specialist. Among these modes and principles of reinforcement are the learner's knowledge of results, the verifiability of information by the learner, the importance of repetition, the clarity of goal, and the differential effectiveness of reward and punishment. Each of these elements . . . [has] several applications in the manner in which information is presented through audiovisual materials. They have bearing on the extent to which *method* is built into the audiovisual material rather than being assumed to be applied by the teacher, e.g., what should be the nature of introductions and summaries in motion pictures, or, in fact, should they exist? Should the film be a mere presentation of experience, or should it be organized so as to indicate its purpose clearly, demonstrate information, and provide for repetition through summaries and applications?

From "Our Debt to Educational Philosophy" by A. W. VanderMeer, *Audiovisual Communication Review,* Vol. 8, No. 5, 1960. p. 46.

Stimulus-Repsonse Psychology and Audiovisual Education

HOWARD H. KENDLER

Professor of psychology at New York University, Howard H. Kendler believes that stimulus-response psychology has devised the most useful system for examination of human behavior and the variables that control it. One view he stresses here is that audiovisual education should arrange optimum conditions for the formation of associations between stimuli and responses.

ANYBODY WHO IS INTERESTED in controlling behavior—and every audiovisual educator is—must first learn to describe it. But, as the history of psychology demonstrates, this is no easy task. One look at raw behavior with its multitudinous facets will immediately raise doubts about any simple language system that aspires to describe behavior.

Psychologists have toiled with this problem since the birth of their science less than a century ago. Many descriptive systems have been created but few have survived. None have attained universal acceptance.

Nevertheless, there is one language system that has stood the test of time fairly well. And that system uses the stimulus-response conception of behavior. Unfortunately for students of behavior, there is still much confusion surrounding this S-R approach. The fault lies as much with its adherents as with its critics.

The proponents of S-R psychology must realize that the data and theories of learning do not *demand* an S-R analysis. The fact that a majority of psychologists who are concerned with learning have adopted an S-R approach testifies to its usefulness, but not to its intrinsic validity. The critics of S-R psychology must recognize that it consists of three separate components. First, it is a language that seeks

to represents psychological events. Second, it is methodological orientation that is anchored in the behavioristic tradition of investigating psychological problems in an objective, experimental manner. Third, it is a classification used by many textbook writers to group together different theories of learning (e.g., those of Guthrie, Hull, Spence, and Estes) that share a common language and methodological orientation.

Our major concern here is with the first and third components of S-R psychology. Behavioristic methodology has numerous philosophical ramifications that go well beyond the boundaries of a paper such as this. Nevertheless, it is helpful to mention that one of the distinctive features of the behavioristic approach is its passionate demand for *experimental* data to justify any interpretation of behavior, whether concerned with the responses of rats in mazes, or with the reactions of humans to a training film. Natural observation, clinical judgment, and personal experience all fall far short of the rules of evidence required by behaviorists to support any psychological explanation, whether couched in a modest guess or within a hypothesis embedded in an elegant theoretical system.

Many reservations have been expressed about describing behavior in terms of stimulus-response associations. Some of these stem from the apparent discrepancy between active, flowing behavior and the inert, static, single S-R association. It seems incomprehensible that raw behavior can be reduced to isolated S-R connections. This objection stems from a misunderstanding. To use S-R language does not mean that complex behavior *actually* consists of S-R connections. Relevant to this point is a quotation from Toulmin, an English philosopher of science, who after analyzing the concept of light, concludes, "We do not *find* light atomized into individual rays: we represent it as consisting of such rays (6:29)." Applying the same idea to the concept of the S-R association results in the following statement, "We do not *find* behavior atomized into individual S-R associations: we represent it as consisting of such S-R associations." The concept of the S-R association, therefore, must be judged not in terms of its ability to provide a clear image of behavior, but rather in its capacity to represent the facts of behavior.

S-R language has proved its worth by the assistance it provides the experimental psychologist who seeks to translate his ideas or hunches into experimental problems from which reliable empirical knowledge can be obtained. This is evidenced by the fact that, during the last four

decades, the S-R learning psychologists have been the most active experimental and theoretical group in psychology. Their productivity is in some measure due to the fruitful and cleansing effect that stimulus-response language has upon designing, reporting, and interpreting research. This language forces the psychologist to focus his attention on objectively defined environmental and behavior variables, and thus encourages the collection of data and the testing of ideas.

The essence of the stimulus-response language is contained in the S-R paradigm, which functions as a *model* of *behavior*. Accordingly, there are three important sets of variables in psychology; stimuli, responses, and the association (the –) between them. The stimulus refers to some aspect of the environment, while the response points to some feature of the behavior. The hyphen represents the degree of relationship between the two. Whether or not the association is formed depends on whether it is reinforced. (The meaning of this term "reinforced" varies in different theoretical systems.)

Not all S-R psychologists are in complete agreement as to whether concepts in addition to those mentioned are needed to explain behavior. Many of them do add a motivational concept to their theoretical schema involving stimulus-response associations. Others believe that this addition is unnecessary. For them, the motivational concept is not basic since its effects can be reduced to the action of stimulus variables. In this paper, there is no need to get enmeshed in such theoretical disputes. When they are viewed from the distance of audiovisual education, most of these differences become attenuated, and some even disappear.

The reasons for the strong and persistent fascination S-R psychologists exhibit for the facts of conditioning should now be clear to the reader. Conditioning provides the clearest picture of how a response becomes associated with a stimulus, and how this connection can be strengthened or weakened. In this complicated world of behavior, conditioning provides the *simplest* form of learning. By observing it closely one can uncover the secrets of the learning process.

Practical Application

No doubt many of the more impatient readers are wondering how the above ivory-tower analysis is related to the practical problems of audiovisual education. The author perceives two important links. The first is obvious. The variables found important in the laboratory are as-

sumed to be important in the educational situation. The second link is concerned with research strategy. The scientific enterprise is a perpetual engagement, the aim of which is to conquer ignorance. Many strategems are used. A few succeed, while most fail. Audiovisual educators may profit by becoming aware of some of the successful maneuvers employed by the learning psychologists.

Before proceeding to the discussion of the implications of S-R learning theory for audiovisual education, one important point must be made crystal clear. And that point is that there is no automatic connection between a theory, whether in physics or psychology, and its successful application to a practical problem. A theoretical principle must first be transformed before it can be applied. Its essence must be converted to fit the needs of a practical problem. And there is no simple rule to describe how this conversion is done successfully. We must rely on those applied scientists who possess the gift for making things work. In short, the learning theorist cannot, no matter how adequate his theory, take the place of the audiovisual educator. He can offer advice and give direction, but in the final analysis, the creation of effective audiovisual programs must emerge from the distillation of theoretical principles with practical "know-how." And only the audiovisual educator can perform that function.

The Important Variables of the Learning Process

Stimulus-response language directs our attention to the important variables of learning. On the theoretical level it simply denotes that for learning to occur, a response must be *connected* to a stimulus. This simple formula, when translated into the methodology of conditioning, means that the organism must make the correct response when the appropriate stimulus occurs *and* when the necessary conditions for associative learning are available. These conditions are easily arranged for in the conditioning laboratory where the experimenter can control the occurrence of all three essential factors: the stimulus, response, and the reinforcement.

These essential conditions are much more difficult to manipulate in a typical audiovisual educational situation such as through use of a training film. Usually there is no great problem in providing the appropriate stimulus, for audiovisual techniques have tremendous advantages over other educational procedures in their ability to present to the learner the stimuli in the most effective manner possible. Roshal

nicely illustrated this point (4) when he demonstrated experimentally that a visual display was most effective when it showed the learning task—in this instance, tying of a knot—as the learner perceived it. An important consideration sometimes overlooked in the audiovisual program is that the stimuli it uses should resemble as closely as possible those that will prevail "on the job." Too often its stimulus situations are those that the learner never meets again. The major problem for the audiovisual educator, however, is to develop techniques by which the appropriate responses to the presented stimuli can be practiced and reinforced. There is no simple recipe for solving this difficult problem. Some suggestions, however, can be made. The educator must know exactly what response he desires his students to learn. Too often the purpose of a training film is vaguely stated. Unless one knows precisely the behavior that is to be acquired, it is impossible to formulate any sensible training program.

Once the characteristics of the to-be-learned response are specified, the task becomes one of getting the student to make it, explicitly or implicitly, in the presence of the appropriate stimulus. Certain points must constantly be kept in mind. First, as stated previously, the response must in some way, partially or completely, be practiced. This problem will be returned to very soon, but it should be mentioned now that it is this requisite which taxes the ingenuity of the audiovisual educator to the limit. Second, to complete the learning sequence, the student must be reinforced for making the correct response to the appropriate stimulus. It is this writer's opinion that the difficulty of this problem has been greatly exaggerated. This view does not minimize the importance of what is commonly referred to as motivation and reward, for these factors are often necessary to get the student to pay attention to the audiovisual training sequence. But if the sequence is successful in presenting the appropriate stimulus and instigating the correct response, learning will more than likely take place.

It is not the intent of the author to imply that the development of an effective audiovisual training program is a simple mechanical task of arranging suitable stimulus, response, and associative (reinforcing) conditions for learning to occur. The above description is of necessity brief and oversimplified. But the fundamental point is simply that the model of behavior involving stimulus, response, and associative processes has been a powerful tool in ordering the experimental data of learning and related phenomena. The belief expressed here is that if it

is used with care and understanding, it will serve as an effective guide for the planning of audiovisual training programs. Fortunately for the educator, there are excellent secondary sources which describe in much more detail the meaning of the S-R model in a variety of situations and which analyze many of the subtleties that could not be touched upon in this paper. (See 1 and 3.)

Developments in Learning Theory

About 30 years ago, when serious attempts to formulate theories of learning were begun, it seemed that the experimental work of the learning psychologists would expand continuously to include more and more complicated situations. Actually, a trend towards simplicity has operated. For example, complicated mazes once widely used to study the learning process of both animals and men have all but been abandoned. Psychologists found that variables associated with the particular maze pattern exerted such a powerful effect that the general principles governing behavior were hidden from view. The trend nowadays is to select experimental situations that highlight the influence of basic variables. The classically simple conditioning and discrimination learning situations (including the simplest maze pattern of all, the *T*) are more widely used than they were three decades ago. Complex problems are no longer used just to see how organisms respond to them. When the effect of new variables is to be evaluated, modifications are introduced into the basic learning tasks. Because these tasks have a known behavioral reference point, the effects of new variables can be judged precisely.

The strategy of limiting the number of experimental procedures in the psychology of learning to a few basic ones, has, I believe, a moral for research in audiovisual education. And this moral is that basic research procedures for audiovisual education must be developed. What is needed—for example, in studying learning which results from training films—is a group of brief sequences that can function as standard experimental problems. Learning occurring in these situations could serve as a base from which the effects of variables in audiovisual education could be evaluated.

One reason why such research devices have not been developed is that the problem of evaluating training films has often been confused with research designed to understand the learning process in audiovisual education. Typically, most training films contain such a con-

glomeration of variables that it is impossible to isolate their individual effects. It should be understood that no criticism is being leveled against evaluation studies. They must be done. The point made here is that the evaluation of training films presents a different problem from that of understanding the audiovisual learning process. As such, they demand two different kinds of solutions.

In addition to the pressures towards simplifying experimental tasks, the recent history of learning theory exhibits another important trend. At one time, learning theorists thought it would be possible to integrate the facts of learning by relating independent environmental variables to the dependent behavior variables; they hoped to do so by postulating hypothetical intervening variables (theoretical concepts) (See 2.) It soon became apparent to them that this approach was not as simple as it seemed. They found that many of the independent variables selected did not exert a single influence. The effect of the variables depended on how the organism responded to them. For example, the influence of delaying the reward for the correct response was found to be not a function of the timing but, instead, of how the organism *behaved* during the delay.

Today, learning theorists are more cautious when they attempt to relate stimuli with overt responses. They want to know whether any other responses intervene between the two. They know that in a very simple conditioning situation it is possible to correlate the environmental stimulus with the response *it evokes*. But they have learned that to explain the behavior, particularly of humans, in more complex problems—such as discrimination learning, learning sets, and concept learning—it is often necessary to assume that mediating events are occurring between the external stimulus and the overt response.

An oversimplified version of a mediational mechanism assumes that the organism reacts to the external stimulus with a covert response which produces an implicit cue that, in turn, elicits the overt response. The all-important feature of this mediational mechanism is that the behavior of the subject is controlled by a cue he himself emits. Therefore, the audiovisual educator interested in teaching a skill involving a mediational mechanism—for example, a verbal skill—must arrange a training sequence that elicits similar mediational responses among the various members of the audience. There are two major ways to do this. The first is to train the audience to make the necessary mediating responses so that later the correct overt response can be associated

with its cues. The other alternative is to select an audience that can make the appropriate mediational responses, and to tailor the training sequence for them.

Once again we find ourselves back to the ticklish problem of encouraging the appropriate response by means of audiovisual training techniques. In an individual training situation where the cues are presented and the student is given an opportunity to make an overt response which can be rewarded when correct and left unrewarded when incorrect, the educational process is easy to control. When the responses are unknown and the reinforcements cannot be punctiliously administered, the problem becomes more complicated.

Some efforts within the traditional audiovisual educational program can be made to overcome these difficulties. One is to require the audience to make an overt response where it is feasible. Another possibility lies in instructing the audience as to what they should do during the film to facilitate training. Still another is to recognize the limitations of the audiovisual medium, and to supply the necessary training of the response in another situation. The final possibility may be the best of all. And that is to incorporate audiovisual techniques with those of auto-instructional devices—teaching machines (5) or programed texts. The best of all education worlds will result from such an arrangement. The stimulus situation will be presented in the best possible manner. Simultaneously, the subject will have a chance to practice the correct response and to be reinforced for it.

Summary

In summary, this paper has been concerned with the implications of stimulus-response psychology for audiovisual education. Initially, it was pointed out that stimulus-response psychology consists of three separate components: a language system, a methodological orientation, and a group of theories. The language is useful in reducing the complexity of behavior to a set of manageable variables. By representing behavior in an S-R manner, it is possible to cope experimentally with, and ultimately to control it. The problem for the audiovisual educator becomes one of arranging the optimum conditions for the formation of associations between stimuli and responses. Some problems associated with this task were discussed. Particular emphasis was placed upon the strategy of devising fruitful experimental techniques and arranging for the evocation of the appropriate response. It was concluded

that audiovisual educational techniques may achieve their greatest productivity when combined with the techniques of teaching machines.

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. . . to shape and maintain learning

> Recent improvements in the conditions which control behavior in the field of learning are of two principal sorts. The "law of effect" has been taken seriously; we have made sure that effects *do* occur, and that they occur under conditions which are optimal for producing the changes called learning. Once we have arranged the particular type of consequence called a reinforcement, our techniques permit us to shape the behavior of an organism almost at will. . . . Extremely complex performances may be reached through successive stages in the shaping process, the contingencies of reinforcement being changed progressively in the direction of the required behavior. The results are often quite dramatic. In such a demonstration one can *see* learning take place. A significant change in behavior is often obvious as the result of a single reinforcement. . . .
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> A second important advance in technique permits us to maintain behavior in given states of strength for long periods of time. Reinforcements continue to be important, of course, long after an organism has learned how to do something, long after it has acquired behavior. They are necessary to maintain the behavior in strength. . . .
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> From "The Science of Learning and the Art of Teaching," by B. F. Skinner. *Teaching Machines and Programmed Learning*. Edited by A. A. Lumsdaine and Robert Glaser. Washington, D. C.: Department of Audiovisual Instruction, National Education Association, 1960. p. 99-100.

Learning And the Technology of Instruction

ROBERT GLASER

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THERE HAS BEEN A SIGNIFICANT lack of fruitful interaction between education and the developing science of learning. Experimental psychologists concerned with learning theory and educational psychologists concerned with instructional techniques and devices have been trained in different academic worlds and in different universes of discourse. One result is the uneasy feeling that educational psychology and the instructional methodologies it generates have not been closely nurtured by a basic mother science. Indeed, it has been a rarity to find a single individual actively concerned both with the development of the basic science of learning and with its technological applications to educational practice. Increasingly, however, current activities indicate that more experimental psychologists who are learning-theory oriented are working on education and training problems.

The general question posed by this movement concerns the nature of an applied psychology of learning and the development of a technology of instruction. Applied research can be defined as research that is oriented toward the development and application of a practical technology. It is a meeting ground where applied and basic endeavors mingle, and where solutions to both theoretical and practical issues are attempted, often in the same experimental program. It appears,

however, that these two endeavors, the science of learning and the development of an instructional technology, have different goals. No one, of course, will disagree with the proposition that the psychology of learning is fundamental to educational technology. The work of basic science is the search for new knowledge and the understanding of it by theoretical organization. Basic science espouses a recognition of ignorance, emphasizing how little we really know and the necessity for discovery. In contrast, applied science and technology concentrate on how much we do know and how this knowledge can be incorporated in practical procedures. The ways in which basic science proceeds do not assure systematic and fruitful interplay between basic knowledge, applied research, and subsequent technology—somebody must work at it. Only by this effort will laboratory findings and theoretical formulations be applied to training and educational practices. The analogy used by Estes (4) is useful here; that is, the relationship between the science of learning and education is more like that of physiology to medicine than like the relationship of medicine to the patient. Expectations of a more direct relationship have been and will be a source of disappointment.

With the above in mind, this paper is essentially atheoretical. The basic notion is that application of current *theories* of learning is less fruitful at present than the application of current *findings*. To illustrate, all psychologists of learning, regardless of their stand on some form of reinforcement theory, agree that reinforcement has a role in acquisition of learning. Vigorous disagreement, however, shows up in theoretical interpretations of the consistent empirical findings. Most of the recent work on teaching machines and programed learning seeks to apply our findings about the effects of reinforcement. The empirical facts have been known for some time, but only recently quite seriously applied in the development of instructional devices. More important, however, than the specifics of current teaching machines is the readiness their development implies to utilize and try out experimental leads. Since the writer has devoted much attention recently to programed instruction, many of the notions involved in this kind of teaching aid influence the subsequent remarks.

Response—What Should Students Learn?

Response is the primary object of manipulation in instructional technology. Because the operations of instruction should result in definable changes in student response, they are designed to bring the responses

under the control of the desired subject matter stimuli. In this respect, the lesson to be learned from the experimental psychologist is a methodological one. To be appropriately developed, the learner's responses should be operationally (behaviorally) specified in so far as possible, just as the task to be learned in the laboratory is carefully specified by the experimental psychologists. One indication of the lack of interaction between the experimental psychologist and instructional practice is the fact that educational literature stresses such terms as "readiness," "understanding," and the "whole child." These matters are amenable to experimental attack and manipulation only when they are behaviorally specified in stimulus-response terms; that is, in actual subject matter situations and observable student performance. This specification is a necessity for experimental psychologists in developing laws of learning. Increasingly, larger and larger units of behavior such as concept formation and problem solving are being studied and analyzed in such terms. And it appears that even these molar units of behavior are influenced by variables similar to those which influence simpler "laboratory" tasks such as trial and error learning and simple conditioning. It is the writer's impression, however, that there has been a general reluctance among educators to submit student responses to analysis in stimulus-response terms.

It is interesting to note that the experimental psychologists who have turned their attention to training research in the military have been confronted with the lack of explicit specification of the behavior under consideration. They have attempted to develop techniques of "task analysis" for behaviorally specifying performance objectives. In this endeavor, the psychologist had to face up to the fact that a definitive terminology for behavioral description was neither available nor forseeably forthcoming from the science of psychology. Much concern has been expressed over this basic lack, and at present—as Melton points out—the development of a taxonomical scheme for specifying the properties of the task to be learned and the objectives of instruction is urgent (15).

In work on programed learning, it has been found convenient to make distinctions between initial responses, auxiliary responses, and terminal responses. Initial responses or initial repertoire comprises the behaviors with which the student comes to the instructional situation. Terminal responses or terminal repertoire comprises the specified final set of behaviors with which he is to leave the situation. Since the behavior brought to the instructional situation is the raw material out of

which the end-product behavior will be shaped, that initial repertoire needs to be laid out. The stimuli to which the student responds at this time should be used in guiding his responses to the subject-matter stimuli to which he should respond at the end of learning. In the course of instructional manipulation between these two points, the student emits responses to reach the terminal behavior. Responses the teacher elicits for this purpose can be called auxiliary behavior. The instructional process seeks to utilize auxiliary behavior to reach the desired educational objectives. This process is facilitated by determining, for each of the stages, the subject matter stimuli—words, symbols, and formulas are examples—to which the learner must respond, and the kind of response each of these requires—solving problems, writing, or building something are examples. These activities must be specified in terms of overt behavior so that appropriate feedback can be obtained by the teacher or teaching devices for use in instruction. Though precise specification of behavior is hampered by inadequate terminology and by a lack of psychological knowledge in analyzing complex behaviors, it is possible to specify to some extent such functions as transfer, understanding, and reasoning in terms which permit instructional control. These matters will be discussed in a later section.

Also involved in instruction are the behaviors imposed on subject matter learning—behaviors described as paying attention, learning to learn, readiness, and so on. These extra-subject matter behaviors also require explicit definition before they can be subjected to manipulation by specified instructional procedures. An illustration of this point is the contrast between the concepts of "readiness" employed in education and "learning to learn" as studied by Harlow (10). Readiness is generally considered to be some function of maturation and previous learning, but has been rather ill defined as a form of response that can be brought under the control of instructional procedures. Learning to learn, on the other hand, is concerned with inter-trial improvement in the course of learning, and has been brought more fully under experimental control than readiness. As a result, "learning to learn" defines a learning principle which is more ready for inclusion in an educational technology than "readiness." This distinction is discussed by Estes (4).

Also to be considered under the topic of response and aside from its explicit behavioral definition, is the way in which student responses are employed in the course of auxiliary behavior leading to terminal objectives. Consider here several of the notions currently employed in

the construction of programed learning sequences for use in teaching machines. First, *the transfer of stimulus control over a response:* At the beginning of such a learning sequence, instructional stimuli are used to evoke responses that are already in the learner's repertoire. As the learner proceeds to perform stimulus-response combinations that are different from these, instruction takes place. What happens in the course of the auxiliary behavior is the gradual transfer of responses to new stimuli, and the bringing of new or extended responses under new stimulus control. The gradual transfer of behavior to new stimuli is what happens, for example, in one method of teaching spelling. The entire word is first shown, then it is shown with missing letters which the learner supplies until he can write the whole word in the absence of contextual stimuli and in the presence of spoken or pictorial stimuli. The essential notion behind this response transfer has general application to educational technology; some of its specific uses have been investigated by Taber and Glaser (19).

A second relevant notion is *response prompting*. When the initial repertoire is specified, the instructional procedure can utilize only these available responses. The instructional task is to get the learner to emit small increments in response moving toward the terminal behavior. It is sometimes thought that the successive approximation procedure employed in a Skinner box is a useful paradigm here. The analogy is useful up to a point. With a Skinner box one often waits for certain responses which are in the direction of the terminal behavior, and then reinforces these responses. In the classroom, it is more efficient to supply a variety of stimulus materials which prompt appropriate behavior which can then be appropriately reinforced. The use of prompting to enable learners to emit new or low strength responses with a minimum of errors is an important consideration in the development of programed instructional procedures. The occurrence of a response is made probable when the presentation of instructional stimuli is designed so that each learning step makes the correct response in the next step more likely. The probability of such success is increased by the use of prompting stimuli based upon what is known about the learner's initial response repertoire at a specific point in learning. Interesting examples of the kinds of prompts in use in program construction are contained in a recent collection of articles on programed learning edited by Lumsdaine and Glaser (15). The characteristics and uses of prompts and cues are provocative for further research and analysis.

Related to response prompting is the withdrawal of cues in the course of auxiliary behavior so that the student eventually responds to the stimuli desired in the performance of the terminal repertoire. As instruction proceeds, response prompts are gradually withdrawn so that the student learns to perform with minimal or covert cues and without apparent external prodding. Teaching machine programs refer to this withdrawal process as stimulus fading or vanishing (18). Again, the general notion seems applicable for technological implementation in instructional devices, but further research on specifics of this process, such as the rate, repetitiveness, and sequencing, is required.

Another parameter of response in instructional procedures is the *form of the response*. On this aspect there has been much pseudo-controversy. In his early work on self-instructional scoring devices, Pressey employed multiple-choice responses. Skinner, in his recent work, has emphasized the role of constructed responses. Psychological experimentors, alert for a controversial variable, rushed to test the effectiveness of these two "points of view." In reality, the basic assumptions of both Pressey and Skinner do not make one kind of responding more correct than the other. It is again a function of where the student is to go, the desired terminal behavior. In the development of instructional devices, however, the form and encoding of the responses can be an important matter. For device construction, multiple-choice responding is much easier to evaluate without the intervention of a human. Write-in responses cannot be so automatically evaluated, and covert responses leave little data for analysis. Some thought has been given to the coding of responses through a number or letter coding system which is more efficient for the transmission of information than the English language, and more susceptible to automatic evaluation.

However, the mode of response needs to be considered in relation to the task to be learned, as has been studied by Evans (6), Coulson and Silberman (3), and Holland (11). Future research must investigate the relationship between particular forms of response and stated educational goals, including the development of understanding and transfer of training. To be considered in this research is the effectiveness of response modes at various educational levels and with various aptitude patterns.

Reinforcement

There seems little doubt at present that a significant aspect of educational technology will be the management of reinforcing operations.

This should continue to be so—despite the continuing development of theories to explain the learning process—since the central role of reinforcement in the acquisition of behavior is a long-standing empirical fact. Notwithstanding the various interpretations of acquisition in terms of "law of effect" and "contiguity," the operations employed to manipulate responses in the course of acquisition are similar for the study of both types of explanatory theories. The concept of reinforcement states that behavior is acquired as a result of a contingent relationship between the response of an organism and a consequent event. Or, as Estes puts it (5), reinforcing operations are those which lead to acquisition when appropriately correlated with response occurrences. Both the basic and applied research in learning are concerned not so much with what reinforcement is, but with how it operates. What both endeavors can supply is specification of the variables which determine the effectiveness of certain reinforcing operations for achieving desired terminal responses.

Work in the science of learning has pointed up certain characteristics of reinforcement which seem firmly enough established for use in the applied investigations which lead to the development of educational technology. One established fact about reinforcing operations is that the correlated or contingent event occurs subsequent to the occurrence of a response. It seems obvious, then, that one principle in the design of instructional devices should be the establishment of such a reinforcing contingency. This contingency is influenced by several factors in the learning situation. For example, a sufficient number of reinforcing response evocations must occur to strengthen the response; that is, to assure high probability of its occurrence in appropriate situations. A further well-established finding concerning response acquisition is that the contingency between a response and a reinforcing event be immediate. Delay of reinforcement may result in little or no learning. In instructional devices, this known fact about the delay of reinforcement has been taken most seriously in the development of teaching machines. In school learning, a major reinforcing event for the student is "knowledge of results," that is, whether or not the response he performs is considered correct. In programed learning techniques such confirmation is immediately forthcoming upon the completion of the student's response. The utilization of this fact of learning in educational technology is very dramatic in light of the frequent delay of reinforcement that occurs in many classroom procedures.

Another established finding in the study of reinforcement is the effect of the intermittency or scheduling of reinforcement contingencies. Essentially this finding takes into account the fact that reinforcing events occur with different frequencies and in different patterns in the course of learning sequences. While a great deal of activity has concentrated on this aspect of reinforcement, it has had little applied development in educational procedures. It has been indicated [see Ferster and Skinner (7), and Keller and Schoenfeld (12)], that with an optimum schedule of intermittent reinforcement, higher and more stable rates of responding can be attained than with continuous reinforcement. Estes and his students have shown that the response of individuals seems to be highly correlated with the overall proportion of reinforcement to non-reinforcement in a learning task. As Estes states this finding ". . . the probability of the response will approach the probability of reinforcement. Thus, . . . if . . . 90 percent of English nouns encountered by a student formed their plurals with 's' and 10 percent with 'n', we could expect that the student would form the plural of a newly encountered noun with 's' about 90 percent of the time (4)." The effects of intermittent reinforcement probably vary with the kind of task being learned. The implication, however, for instructional procedures is that this factor is influential, and requires applied research for appropriate practical implementation.

Interference and Transfer

As a general premise, it can be stated that interference in learning which results in forgetting and a decreased rate of acquisition is a function of competition between the response under consideration and other responses learned prior to, or subsequent to, it. The results of pertinent experimental study indicate a number of variables to be considered. Transfer comes about as a result of similar stimulus components in different learning situations so that the response is generalized. The education of a student involves, to a great extent, two aspects: (a) learning to respond to similar elements in stimulus situations—for example, to so generalize as to recognize all words of a certain class as nouns; and (b) learning to make differential responses to different stimulus situations—that is, to form such discriminations as are required to differentiate between nouns and verbs. Much instructional procedure aims at teaching students to generalize within stimulus classes and to discriminate between class instances. Interference in

instruction often comes about in the course of this generalization-discrimination process, but it can be overcome by practice sequences presenting many response instances which progressively narrow the discriminations to be made. In teaching machine programs, "discrimination sequences" are often used to teach the student different responses to two stimulus situations which in the course of instruction might be confused. The series is set up so that the learner responds correctly to the appropriate stimulus, and also identifies situations in which a particular response is inappropriate. In so far as possible, he is not permitted at any point to perform an inappropriate response. Such a discrimination series should minimize interference resulting from the similarity of stimulus elements.

Interference often results from unintentionally evoking emotional responses which may be incompatible with the responses to be learned. The results of learning experiments point up situations in which such behavior is produced. In the process called "extinction," a response is permitted to occur in a situation where there are no contingent reinforcing events. As a result, the response attains a low strength and can be replaced by a response more frequently reinforced. In the course of extinction, it is noted that emotional or frustration behavior occurs. It is also true that after a history of continuous reinforcement, the omission of a reinforcement is frustrating and similarly results in certain behaviors which may be incompatible with learning the appropriate response. In the development of instructional methodology it seems desirable to minimize the possiblity of the occurrence of such behaviors. One way of doing so might be to provide a history of intermittent reinforcement; thus, subsequent omission of a reinforcing event would be much less frustrating.

In education there has been much concern about transfer of training. The focus here is the student's ability to utilize his learning in stimulus situations which differ to some extent from those in which that learning occurred. Interference in the application of learning to these new situations often arises. The existence of positive or negative transfer can be presumed to be a function of the generalization-discrimination series that occur in learning. The notions of generalization and discrimination indicate that the search for tranferable elements is less useful for the development of an educational technology than is the study of transfer produced through practice with graded sets of experiences containing a variety of instances with varying stimulus character-

istics. This matter will be further elaborated in the section on reasoning and understanding.

An extensive body of research in the psychology of learning is the work on interference in verbal learning that is characterized by the investigations of Underwood (21) and others. They have studied the effect of a host of factors on the learning of a restricted class of verbal behavior. The factors include such variables as meaningfulness, task similarity, active recitation versus passive study, affective characteristics of the material, whole versus part learning, and such dependent variables as spread of effect and incidental learning. The direct relationship of these factors to classroom learning is difficult to see but, as Underwood has pointed out, it may be possible to determine their relevance to educational technology through classroom experimentation (20).

Practice

It is established that review and repetition are necessary for aquisition, and also for maintenance of previous learning. Of major interest are the conditions of practice over the course of learning trials. Such conditions are indicated by many of the aspects of learning discussed above. The general implication for instructional devices is that they must incorporate the appropriate amount of review and repetition necessary to maintain previous learning, including those concepts which need to be strengthened and used in further learning. Sufficient practice is necessary so that early material is mastered before or while new material is introduced. Practice should incorporate the conditions which facilitate learning. However, for many subject matters the effects of particular characteristics of practice and review upon response strength and retention are not known and must be determined by empirical classroom investigation.

The distribution of practice has been a very frequent variable in experimental study, and at present many experimental psychologists would agree that learning often appears to be most effective—that is, acquisition is faster and performance levels are higher—when practice is divided into a number of daily trials (4). This conclusion suggests that instructional devices should include directions for spacing learning sessions so that practice is interspersed with other instructional procedures, including discussion and laboratory practice.

Reasoning and Understanding

Reasoning and understanding as behavior developed by instructional procedures have been brought into focus by the present work on programed instruction. When teaching machine programs are discussed, teachers frequently say something like this: "Yes, the student seems to be learning, but does he really understand?" The best reply to this question prods the teacher to define the observable terminal behavior he desires. That reply goes something like this: "Tell me what kind of behaviors (perhaps test performance) you would like the student to display so that you know he is understanding and reasoning." With such terminal responses specified, it is then the task of educational technology to determine what combination of educational experiences including teachers, devices, and self-study, result in this behavior.

Concerning the role of such instructional aids as programed learning devices, it must be pointed out that terminal behaviors defined as understanding, concept formation and utilization, and reasoning seem to be brought about by continuous variations of the stimulus context in which the student responds. These variations are set up so that the student gradually receives new information, learns to make progressively finer discriminations and appropriate generalizations, and also learns to apply his responses to a wide variety of situations. This process helps to enrich the student's breadth of learning, and is an operational way of defining the development of understanding. Programed instructional sequences can provide a series of well-organized examples leading the student to develop abstractions and rather complicated concepts. As pointed out by Skinner, "An important goal is to 'enrich' the student's understanding by inducing him to permute and recombine the elements of his repertoire" (16). At the extreme of these stimulus and response variations, the goal of instruction is really not concerned with the learner's response to any one situation. This is only an example of an abstraction. The objective is that the student acquire not a uniform and explicit set of responses about a particular concept, but rather a repertoire which is applicable in a variety of situations so that he can use the concept to solve problems, describe it to others, modify it for certain purposes, build a model of it, and so forth. This terminal behavior can be defined as reasoning with, or understanding, a concept. Appropriately programed sequences which can be put into instructional devices and employed with other kinds of learning experiences can provide the

stimulus and response variation which contributes to the growth of understanding.

Motivation

When one measures the usefulness of a learning concept in terms of the extent to which it generates applied research and applications for educational practice, the concept of motivation does not fare well. Neither the theoretical nor experimental concern with this concept presents readily translatable findings. In fact, many learning theorists have avoided the word in attempting to account for learning phenomena in more operational terms. In general, one is tempted to say that motivation includes those events and operations that make a particular response-event contingency reinforcing. Such a statement, however, indicates current ignorance of a variety of factors in the learning process which need to be identified.

Motivation as studied has been related to the drives produced by certain experiences in an organism's history. In the laboratory, the operation of deprivation—withdrawal, for example, of food and water—has been employed to make certain events reinforcing. It taxes one's ingenuity, however, to see how deprivation can be employed in the use of instructional devices. Furthermore, much research is required to investigate the nature and use of secondary reinforcers, such as school grades, the learner's desire to be correct, or for approval and status.

Sometimes the word motivation is used to imply certain behaviors that are the outcomes of instruction. For example, when a student continues to study after the usual classroom hours, or when he works independently on special projects, or when he uses the library to look up topics related to his school subjects, we often say he is "well motivated." To use "motivation" in this way, it is best for the teacher first to state such terminal objectives in behavioral terms, and then to introduce instructional practices that produce these behaviors. The judicious use of reinforcement is motivating in this sense. When a student receives frequent reinforcement in the course of learning, he often appears to become quite interested in the subject matter, and his constant success in handling it makes him act in a way we can properly call motivated.

It is, of course, presumptuous to attempt to talk in any definitive way about the problem of student motivation. Much research needs to be considered, such as the effects of anxiety as studied by Spence (18); the effects of "social conditions," including cooperation and competi-

tion; the generalization of motivating effects from one motivating condition to another, as studied by Kendler (13) and by Braun and others (1); and Glanzer's discussion of experimental work on curiosity and exploratory drive (8). For technological purposes it seems practical at present to define the terminal behaviors which fall into a class called "showing motivation." The task then is to manipulate the instructional situation in a way so as to produce these behaviors with some degree of consistency.

If any theoretical position has been taken in this paper, it is a behavioristic one. The underlying concept is that the process of instruction can be made an explicit subject matter for scientific study from which a technology of instruction can be developed. Instructional devices developed on this basis require us to become behaviorally explicit both about instructional objectives and about the procedures employed to attain them.

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. . . guidance for understanding

. . . . It seems certain that programmed learning sequences can . . . shape the characteristics of behavior which not only permit the student to respond to particular situations in particular ways, but which enrich his understanding and develop his creative capabilities.

. . . The demonstrable advantage of 'learning by doing' can best be realized only if the student receives sufficient guidance and feedback so that he practices those responses that will lead him to the desired proficiency. Without adequate guidance, much of his time may be dissipated in irrelevant activity, and he may lose interest through frustration and lack of adequate reinforcement. Further, he may be practicing inefficient or incorrect patterns of response which later must only be unlearned and corrected. This is as true in academic subjects as it is in skills like violin playing and tennis.

From "Concluding Remarks." *Teaching Machines and Programmed Learning*. Edited by A. A. Lumsdaine and Robert Glaser. Washington, D. C.: Department of Audiovisual Instruction, National Education Association, 1960. p. 570-71.

. . . to select the best method

[One] element central to the statement and clarification of educational directives is the definition and description of the essential characteristics of various types of learning. The development of concepts, the nurture of perceptual skills, and the reinforcement and restructuring of attitudes appear not only to call for different types and levels of abilities, but also for differing methods and materials of instruction. We all recognize, for example, that although a clear understanding of the facts of racial similarities and differences may be logically incompatible with racial prejudice, individuals possessed of the facts often remain bigoted in outlook. It seems logical to suppose, then, that the most appropriate and effective materials and methods for teaching concepts might not be the same as those recommended for the reinforcement or restructuring of attitudes. How these materials should be different and how their use should be modified is within the province of the psychology of learning. . . . Should attitudes be built through frankly emotional appeals, or must only the rational approach be used?

. . . Certainly the psychology of learning and the principles of human development are a primary foundation for answering questions of pedagogical procedure. The general audiovisual specialist should be able to quote 'chapter and verse' to support his recommendations as to method; therefore, he must draw heavily from his training in differential and integral educational psychology and human development.

From "Our Debt to Educational Philosophy" by A. W. VanderMeer, *Audivisual Communication Review*, Vol. 8, No. 5, 1960. p. 47.

Motivation and the Communication Processes

FREDERICK J. MCDONALD

Assistant professor of education and psychology at Stanford University, Frederick J. McDonald believes that audiovisual devices stimulate interest in learning tasks, and that there is an interaction between their orienting effects and personality characteristics.

THE ASSUMPTION THAT HUMAN BEHAVIOR is "motivated" is common. Workers in such diverse fields as education, advertising, and politics stress the importance of analyzing men's motives and the value of devising ways to utilize motives to foster desired changes in behavior. The notion of motivation seems so intuitively obvious that questioning its scientific or practical utility would appear temerarious. Yet Cofer, in a critical review of recent literature on motivation, concludes that, "if present trends continue, motivation as a distinct concept, coordinate to other psychological concepts, may well disappear (3:194)." Irwin, however, in a comparable review only two years later, while agreeing "on the nearly useless status of the word 'motivation'" cannot agree with these diognoses and prognoses (11).

The non-psychologist may well be surprised by the lack of agreement among psychologists on a concept that seems obvious and that is an integral part of common-sense psychology. Such disagreements cannot comfortably be dismissed as scientific games; they have arisen as psychologists have attempted to make sense out of an enormous array of experimental data. Hopefully stated, the experimentation and theorizing that will eventuate in an attempt to resolve these disagreements will result in more comprehensive explanations of human behavior. Should the journeyman construct "motivation" disappear from the

scientific vocabulary of psychologists, it will be replaced by concepts that will eventually have greater practical import.

This prediction rests on an act of scientific faith. What remains for the professional who has found the notion of motivation persuasive, and whose pragmatic concerns seem to have profited from utilization of this concept? Certainly teachers will continue to plan to "motivate" students, and it is difficult to visualize an advertising industry without "motivational" research.

An analysis of this construct may prove useful to specialists in communication media for the simple and obvious reason that their procedures and techniques usually involve some assumptions about motivation. Communication specialists, for example, have long recognized that the impact of a communication on a captive audience may be radically different from its impact on a voluntary audience. Presumably, the captive and voluntary audiences are motivated differently to receive the communication.

That such an analysis may be eminently useful will occur to anyone who considers the state of our practical knowledge of ways to motivate human beings. As Miller has noted, we know far more about communicating information than we do about motivating people. He concludes that "the time is right for a clarification of issues and a formulation of some tentative hypotheses (18:66)." No firm commitment to any particular theory of motivation is required to make this analysis. But an understanding of competing theories may be a first step toward formulating hypotheses.

The Communicative Act

A conceptual model of the communicative act is necessary if we are to analyze the role of motivation in the communicative process.[1] A *communicative act* may be defined as any observable behavior by which information is transmitted from an information source to a human recipient.[2] This definition implies that the human object of the communication "receives" the message in the sense that he is at least aware of it.

[1] In fact the particular conceptual model chosen may not require a set of motivational constructs, or may deemphasize their role. Cybernetic conceptions of man's relation to his environment usually emphasize his information-processing capacities and factors influencing them. Motivational constructs appear in these conceptions in the form of utility matrices which account for action choices. The motivational construct plays a less strategic role than in behavioral and perceptual theories (23).

[2] This definition is identical, except for minor changes, with that provided by Newcomb (19: 141). Note that an *interaction* may be defined as an exchange of information between two information sources.

This conception of a communicative act is sufficiently general to encompass an infinite variety of information sources. For example, the source may be a teacher lecturing or an instructional film. The amount of information communicated may vary quantitatively from small amounts as in a simple command to large amounts as in the instructional film, the lecture, or the textbook. The communication source may also be described in such other terms as clarity-ambiguity.[3]

This conception makes heuristic the idea that basic motivation-learning problems are likely to be generic to all communication media. Thus, the question, "Are audiovisual devices motivating?" leads to the same problems as the question, "Are teachers capable of motivating students?" Similarly, we probably should not expect to meet radically different problems when we ask, "Can audiovisual devices arouse curiosity?" than when we ask, "Can teachers arouse curiosity?"

It is not to be concluded that a particular communication medium may not have effects uniquely different from those of other media. These uniquenesses are, however, a matter of experimental demonstration; but, historically, they unfortunately have been matters for speculation or assertion. The emergence of interest in auto-instruction may lead to clarification of the function of a teacher in learning. Present research in this area, albeit limited, suggests that many traditional functions of teachers may be performed as well, or better, by auto-instructional devices (16). Research strategies are needed to guide exploration of differences among media in their utility for motivating, guiding, and strengthening learning.

The Learning Act

A behavioral event which produces learning must meet three general conditions: (a) a desired response must be elicited; (b) the response must be associated with stimuli (internal or external) whose future occurrence is likely to elicit the response; (c) the association of stimuli and response must be strengthened to increase the probability of occurrence of the response to the stimulus.

A simple example will illustrate the necessity of these conditions for learning. Assume that we wish to teach a child how to multiply two digits, and take one instance of such products. We wish to elicit a re-

[3]Important theoretical problems in determining these dimensions are ignored here for the sake of brevity. Some of these dimensions are response-inferred, that is, we infer that the communication has certain properties from the reactions of people to it. Such inferences involve us in the problem of the relation of the receiver's characteristics to his perception of the message.

sponse, a statement of the product, to the stimulus symbolizing their multiplication. To elicit the response, we usually provide an example of the one desired, and indicate we wish the response example to be repeated. By providing some symbolic representation, we have provided a stimulus to which we want the response associated. Through rewarding the child's response to this stimulus, we strengthen the learned association between symbol (stimulus) and response.

This example ought not to blind us to the complexity of the learning involved. Note that encouraging the child to repeat a response presupposes he has learned this kind of general response. Note also that the complexity of the analysis depends on the complexity of the response to be learned. If we had defined the desired response as determining the product by analyzing the relation of multiplication to addition, we would have had to describe a complex sequence of responses to be learned.[4]

The first condition is definitional in character. It is another way of saying that learning involves a change in behavior pattern either by the acquisition of new responses or by the extinction of old ones. The second condition is implied in the definition of learning as a behavior change resulting from a change in the conditions (internal or external) impinging on the person. The third condition is amply supported by experimental data, and appears in psychological literature under a variety of labels—law of effect, reinforcement, reward and punishment, and need satisfaction, to name a few. Simply put, it means that behavior change is determined by the consequences that eventuate when a response is made.

Several practical advantages accrue from analyzing situations designed to produce learning in terms of these three conditions. First, we are more likely to attend to the variables that influence learning. Secondly, we are more likely to make effective use of teachers and such teaching devices as audiovisual materials in organizing teaching-learning systems. Porter has provided an analysis of teaching devices using the model implicit in the conditions described above (20). From his analysis it may be concluded that many audiovisual devices must be integrated into a larger system if they are to be useful in improving

[4]The conditions listed above are very general and are compatible with all major theories of learning. Theories may differ in the technical language used to state these conditions. They also differ on their conceptions of the cruciality of the second and third conditions for learning. Hilgard's description and analysis of major theories of learning is recommended for an extended treatment of these differences (8).

learning. Other devices provide relatively complete systems for learning by the criteria we have invoked.

A third advantage is that an understanding of these conditions provides a starting point for the development of research strategies to investigate the effectiveness of any teaching device. It seems rather pointless, for example, to make gross comparisons of the live and televised lecture. Either or both may or may not provide the necessary conditions for learning; to the extent that both arrangements provide similar conditions we would expect similar results (a not uncommon finding in recent research). But such research tells us practically nothing about why students learn under either condition. Neither is our understanding or identification of the critical procedures in either condition improved.

Learning Acts and Communicative Acts

A communicative act as defined may not lead to learning as described. It formally includes only the second condition necessary for learning. Before we can guarantee learning by communicative acts we need to know about the information-processing characteristics of the communication recipient. We also need to know the relation of characteristics of the communication source to characteristics of the communication recipient.

Studies of the information-processing characteristics of the communication recipient are numerous in psychological and educational literature, but appear under other labels. The study of the problem of educability running from Binet's development of test procedures to the most recent research on individual differences has been directed to determining the relation of individual learning capacity to what can be learned and how it might be most efficiently learned. This problem is a generic one. Content presentation via film, lecture, or book is essentially the same process, and we ought to expect the relations of this presentation to characteristics of the recipient to be similar across media.

At the present time there is no adequate general theory on the relation of presentation variables to individual variables. However, studies available in the communication literature support the general hypothesis that the effectiveness of such procedures as a film presentation are related to characteristics of the learner (22). The research strategies for the investigation of this problem have been similar to those used in the investigation of educational methods generally. These investigations typically compare one method of presentation with another against

some criterion of effectiveness. The need exists for another kind of research strategy, as Cronbach has noted: one in which the interaction between individual variables and stimulus variables is systematically explored (5). This kind of investigation is necessary to establish procedures for utilizing particular communication procedures with particular individuals.

Motivation and Learning

Motivation is generally agreed to be a necessary condition for learning, though theorists disagree on the precise character of the construct and its specific role in learning. In psychological theory, motivation has been the construct used to account for the energizing of behavior. An initiating state is postulated to account for the increased activity of an organism. As we have noted, however, the learning of specific responses depends on the consequences of making that response.

One general theoretical position relates consequences to motivation by postulating that those responses are learned which "reduce" the drive state (motivation) of the organism. Hull's theoretical conceptions are representative of this general position (8). An alternative theoretical position conceptualizes motivation as arousing goal-seeking behaviors which if successful lead to need-satisfaction (i.e., a restoration of motivational equilibrium).

The differences between these two general positions are mainly differences in analytic methods, experimental strategies, and problems chosen for analysis. Estes has stated that many theorists now regard the two positions as "alternative modes of description, each offering advantages on some occasions and for some purposes (6:753)." The common conception among theories is that motivation is an initiating state leading to increased response activity, the consequences of which strengthen certain responses and heighten the probability of their future occurrence under similar conditions.

The arousal of this initiating state may be effected either by internal changes in the organism or by external stimuli. Obviously, the influence of external stimuli on the arousal of this initiating state is a central problem for anyone who hopes to foster behavior changes through environmental manipulations. For the communication specialist, an important question is: what characteristics of an audiovisual device are likely to motivate a person?

Assuming audiovisual devices may have some motivating properties,

it is important to remember that learning is not thereby guaranteed. It is not necessary, however, for an audiovisual device to have motivating properties if it is used in conjunction with other procedures for motivating learning. In a notable experiment, for example, students learned more from films if they had teachers who were rated as better, even though the teachers had nothing to do with the film presentation (25). We may infer that in these classes the teachers had made more effective provisions for motivating students and for establishing the other conditions requisite to learning.

The literature on the motivating characteristics of audiovisual devices is not encouraging (10, 1). Studies on motivation with audiovisual procedures typically present some type of communication, and then assess the extent to which a desired behavior change has occurred. It should be noted that in such studies the extent to which the desired change has occurred is used as criterion of the motivational effect of the presentation. But other factors, as we have suggested, may influence learning, and their absence in an experiment may account for the assumed motivational ineffectiveness of the procedure used.

That a communication may arouse motivation but not produce a desired change is suggested by a study of fear-arousing communications conducted by Janis and Feschbach (12). In this study, the condition presumably most motivating was least effective in producing acceptance of the communication. One explanation is that the communication did heighten anxiety but the recipients learned to avoid it (by not listening or by readily accepting a counter-communication as a way of reducing anxiety).

A basic research problem seems to be to separate for analytic purposes the characteristics of a communication that motivate behavior and those that enhance learning. A film may arouse interest, but be quite ineffective for producing learning; for example, the film may not provide clear specification of the responses to be learned, or reinforcement of the responses if and when they occur.

Orientation and Communication

Any communication to be effective requires the intended recipient to be attentive. This problem is essentially a motivational one in most instances. Attention to a communication involves selection among available stimuli, and the motivational problem is how to energize and direct selecting and attending responses to a particular stimulus complex.

It might be profitable if the research literature on the effectiveness of audiovisual procedures were organized in terms of their utility for stimulating orienting responses. The problem of the "passive" and "captive" audience is a problem because we know so little about the effects of any communication procedure on orienting the recipients to the communication. Active involvement in a learning situation is assumed to be effective for stimulating both motivation and response. Active involvement through role-playing is effective in producing attitude changes (13). Active correction of errors leads to more rapid concept attainment (24). However, some forms of activity are not uniformly more effective in enhancing learning (4, 14). Perhaps the relative effectiveness of the highly generalized procedure called "active involvement" depends on the extent to which it focuses the subject's attention on the relevant discriminative stimuli, and also on the extent to which it provides reinforcement for response trials.

A revival of interest in the use of stimuli to arouse attention, and curiosity has occurred in the past decade (11, 2). The experimental work has led to a re-analysis of motivational constructs. This work is not sufficiently advanced to supply guides for practice, but it should focus the interest of theorist and practitioner on variables associated with the orienting properties of external stimuli.

Pre-Disposition and Orientation

An abundance of research literature is available to support the general hypothesis that a person's selection of the aspects of a stimulus complex to which he attends is a function of stable personality tendencies. Postman concludes that perceptual behavior (of which orienting responses are presumably a class) "may be conceptualized in terms of learned response tendencies (21:99)." These stable response tendencies are important determinants of the aspects of a communication to which a person will attend (17).

We have also known for some time that arrangements of stimuli create learning sets which are important factors in stimulus selection and response variation (15). Harlow's recent experimental work has demonstrated the relevance of learning sets to rate of learning (7). Communication research literature contains some studies which suggest that preparation for a film enhances its effectiveness (26). The effective variable in such procedures may be the creation of relevant learning sets.

The general research questions seem obvious: What are the effects of any stable personality characteristic (attitudes, motivational tendencies, etc.) on motive-arousal and learning when a particular audiovisual device is used? Are some predispositions relatively unimportant for some kinds of communication content? How can audiovisual stimuli be arranged to create learning sets?

Conclusion

The discussion in this paper leads to the conclusion that the focus of study on the problem of audiovisual devices and motivation should be the manipulation and control of orienting responses. Investigations so centered must inevitably explore the interaction of predispositions and the stimuli provided in a communication. From a practical point of view, this problem is critical because audiovisual procedures are used in educational settings with "captive" audiences. These investigations should improve our knowledge of the specific communications to use with a particular audience.

An important part of this investigation should be concerned with the creation of learning sets. It would not surprise this author if such investigation should prove that the primary utility of audiovisual procedures lies in their effectiveness to create such sets. Their effectiveness in other respects may be largely administrative.[5] In any event, the motivational problem may be studied more fruitfully if conceptualized as a problem in controlling orienting responses and in creating learning sets.

Finally, this paper has suggested that the motivation and learning problems in using an audiovisual device are not essentially different from those created by the use of any other communication source. Certainly an analysis of previous research strongly suggests that the effectiveness of a communication source depends on the extent to which provisions have been made for the creation of all the conditions requisite for learning. A profitable research strategy may well be to turn attention away from audiovisual devices as alternatives for other procedures, and to study their effectiveness as part of a complex teaching-learning system. Humorously, but not facetiously, we may note that the teacher is an audiovisual device, one whose history of effectiveness resembles that of other audiovisual devices.

[5]This would be one conclusion from the research that demonstrates the comparable effectiveness of a teacher and a film.

The time seems ripe to conceptualize teaching-learning systems in terms of variables whose effectiveness on motivation and learning is demonstrable. This conceptualization of communicative acts should be productive of increased understanding of the utility of any specific procedure, and may lead to the invention of new procedures and technological devices.

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. . . to prepare students for later learning

For learning to be effective a quite close degree of control needs to be exercised during early stages while basic skills and patterns of response are being shaped. However, as fundamental stages are mastered, it is equally important for guidance to become more flexible so that the student is given adequate opportunity for freer expression and the exercise of individual talent and creativity. The basic emphasis in programmed learning on guidance and control . . . sometimes leads to a concern that the student may develop an undue degree of dependence on being 'spoon fed' by the easy progression of steps in a program . . . the student must learn to cope with an unprogrammed world in which he will have to learn from newspapers, reference books, and personal experiences. Clearly, any good teaching procedure must 'wean' the student from dependence on special helps which he is given during early stages of learning. . . . The later stages of a programmed-learning sequence need to be designed to . . . prepare the student for subsequent learning. It can do this both by developing habits of careful, sustained attention to textual material and by leading him to master fundamental concepts and transferable skills which are necessary as tools for further independent study, laboratory work, or effective group participation.

From "Concluding Remarks." *Teaching Machines and Programmed Learning.* Edited by A. A. Lumsdaine and Robert Glaser. Washington, D. C.: Department of Audiovisual Instruction, National Education Association, 1960. p. 571.

Human Learning and Audiovisual Education

LEO POSTMAN

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IT IS COMMONPLACE TO SAY that the experimental analysis of human learning must provide the theoretical and empirical basis for educational practice. The application of laboratory findings to learning in the classroom has, however, been slow and sporadic. The major obstacles to application have been the obvious differences between the experimental laboratory and the classroom—differences both in subject matter and in the conditions of training.

Experimental psychologists have devoted much of their research efforts to the analysis of rote learning and motor skills. These problems continue to be chosen widely for investigation because they permit rigorous experimental control and quantification, and because they yield data which are coordinate to the constructs of contemporary learning theory. While the body of empirical facts has been growing rapidly, we still know very little about the generality of the functional relationships which have been established in standard experimental situations. To make decisions about the generality and applicability of experimental findings on *a priori* grounds is, of course, an error. These questions must be answered empirically. It is reasonable, however, to proceed from the

working assumption that there is continuity between the principles governing learning in the laboratory and in the classroom. In testing this assumption, a first essential step is to describe the problems of classroom learning in terms which bring out clearly and explicitly the similarities and differences between the situations manipulated in the laboratory and the conditions of practical application.

For descriptive and analytic purposes, it thus becomes useful to describe the aim of audiovisual education as the establishment of associations between selected classes of stimuli and responses. When the method is successful, the auditory and visual displays which are the teacher's basic tools are more likely to elicit correct or socially desirable responses at the end than at the beginning of instruction. The teacher's essential concern, however, is less with classroom behavior as such than with the student's readiness to respond effectively to situations he will encounter later on. The instructional methods must, therefore, be designed to maximize transfer of training to new situations, and to assure long-term retention of the habits established in the classroom. It is apparent that the experimental and theoretical analysis of the conditions of *acquisition*, *transfer*, and *retention* of associative habits has potentially important implications for research and practice in audiovisual education. In the sections which follow, we shall summarize briefly some of the basic generalizations which can be supported by the results of experimental studies of these processes. Before doing so, we must emphasize again that these generalizations should be regarded as sources of hypotheses to be tested in the specific context of audiovisual education, rather than as rules ready for use by the practitioner.

THEORETICAL FRAMEWORK

The major body of experimental research on human learning and memory has been carried on within a theoretical framework which can be described as "associationistic functionalism." That is, the basic experimental procedures and methods of analysis reflect an associationistic conception of the learning process. The wide reliance on such techniques as serial and paired-associate learning with verbal materials is a case in point. Thus, the descriptive language of investigators of human learning has been predominantly that of a stimulus-response psychology. Concepts derived from classical conditioning—including generalization and extinction—and from trial-and-error learning, have been used freely in the conceptualization of verbal and motor learning. However, with a

few important exceptions, the commitment to formal stimulus-response theories and, indeed, to any system of theoretical concepts, has been loose and pragmatic. What has given continuity to the experimental research on human learning has been a determined emphasis on functional relationships which reflect the effects of manipulable variables on learning and performance. John A. McGeoch—who more than any other psychologist helped to determine the course of American research on human learning—was an exponent of *dimensional analysis* without commitment to a systematic theoretical position (2). In dimensional analysis, learning tasks are ordered with respect to a number of characteristics which apply to all of them to a greater or lesser degree. One of the major axes of reference is the verbal-motor dimension along which learning tasks may be classified from purely verbal ones at one extreme to predominantly motor ones at the other. Another dimension is the degree of discovery of the correct response required of the subject, ranging from strictly prescribed rote series to problems whose solutions the subject must find on his own. Still another dimension of variation is the extent to which successful performance requires a response to relations rather than to absolute properties of the stimuli—for example, the choice of the larger of two objects rather than one of fixed size. Learning tasks vary, of course, in many other ways, but these examples may suffice to illustrate the purposes of dimensional analysis. (For a full exposition of this approach, see 3.)

A pragmatic orientation is also reflected in the usage of such basic descriptive terms as stimulus, response, and association. The term stimulus is used broadly to refer to the antecedent conditions of responses. Response is used equally broadly to refer to any circumscribed segment of behavior the occurrence of which can be reliably measured. The establishment of an association, when used as a descriptive term, implies no more than a change in the probability that a given stimulus will elicit a specified response. In the words of McGeoch, psychological events are associated when "as a function of prior individual experience, one [event] elicits or stands for the other. The events in question may be of any kind whatever, so long as one calls forth or stands for the other. They may be analytically as small as a pin point of light and a single muscle twitch thereto; they may be as large as the total perceived field of objects and the most complex possible response which can be regarded as a single unit. The essential aspect of association is the relation between or among sequences of events." (2:25.)

Within this general framework, steady and significant progress has been made in experimental and quantitative methodology, and in the accumulation of a solid body of empirical facts. Theoretical developments have been tied closely to the increases in empirical knowledge. There have been considerable gains in the precision and predictive power of the concepts used in the analysis of limited sets of interrelated data—including the facts of serial learning, distribution of practice, interlist transfer, and interference. The development of such "miniature systems" has not, however, led to the elaboration of a formal comprehensive theory of human learning. Thus, theoretical progress continues to come through eclectic accretion. In recent years, the use of mathematical models in the analysis of learning data has claimed considerable attention, as exemplified by information theory and statistical learning theory. Again such attempts have been largely limited to the construction of "miniature systems" designed to handle the results obtained in highly circumscribed experimental situations.

Reinforcement

No explicit mention has been made thus far of the concept of reinforcement and its status in the experimental analysis of human learning. The fact that the consequences which follow each response significantly influence the course of learning hardly needs reaffirmation. Considerable caution is required, however, in the application to human learning of one conception of reinforcement which was developed largely in studies of animal behavior: Reinforcement through reduction of a biological need clearly has little relevance to most studies of human learning. Instead, symbolic equivalents of rewards and punishments are used with human subjects—including announcements of *right* and *wrong*, other knowledge of results, and prompting. Such consequences, obviously, are not only rewarding or punishing but also give the learner needed information. In many situations it is difficult to make a clear distinction between information on the one hand, and reward or punishment on the other. Such a distinction becomes impossible when exposure to the correct response is used as the method of reinforcement. Some writers prefer to avoid this problem altogether, and define any condition which increases the probability of a correct response as reinforcing. Under this definition, the frequency and temporal schedule of exposures to the learning materials become parameters of reinforcement. While such a formulation leaves open the mechanism by which stimulus-response

associations are strengthened, it continues to emphasize the importance of the temporal relationship between the learner's own responses and environmental events.

A similar caution is in order when motivational concepts are applied in the interpretation of studies of human learning. The reference is usually to complex social motives and attitudes which are difficult to manipulate or measure. In spite of a long history of experimental attempts, there is still little or no clear evidence that the affective characteristics of the learning materials influence either the speed of acquisition or the rate of forgetting. Attempts to manipulate the subject's "involvement" in the learning task have also yielded indifferent results. We are not suggesting, of course, that motivational variables are of no significance in human learning; we merely point out that there is only scattered and inconclusive information about their mode of action.

EXPERIMENTAL FINDINGS

We turn now to some of the empirical facts of human learning which may be of potential interest to investigators and practitioners of audiovisual education. Much of the evidence on which our generalizations are based has been obtained in experimental studies of verbal learning.

The Process of Acquisition.

The process of associative learning can be divided into two successive stages: a response-learning stage, and an associative stage proper (4). During the first stage, the prescribed responses are established as integrated units of behavior which are available for performance. During the second stage, the response units are linked to the appropriate stimuli. The distinction between the two stages can be readily illustrated by an example from verbal learning. Suppose a subject has the task of learning a list of paired associates—that is, to give a prescribed response to each of a series of stimulus items. He can, of course, perform this task only after the response items have become part of his verbal repertoire. If the responses are nonsense items, there may be a protracted period of response integration before the units become available to him. If the prescribed units are words already in his repertoire, he must learn to restrict his responses to these units. Once the responses are integrated and available, associative connections with the stimulus terms can be established. The two

stages undoubtedly overlap in time, but the distinction between them is useful for analytic purposes.

It is clear that the durations of the response-learning stage and the associative stage determine the total time required to reach a given criterion of performance. The duration of the first stage will depend both on the initial availability of the prescribed responses to the subject, and on the opportunities provided during training to integrate and rehearse the responses which are at less than requisite strength. The critical importance of the initial availability of response units has been demonstrated in studies of the effects of language habits on the learning of verbal associations (4). The more frequently a verbal unit has been experienced in the past—that is, the more fully it conforms to linguistic usage—the more rapidly it enters into associations with new stimuli. Thus, the speed at which the first stage of acquisition is completed varies directly with the past frequency of usage of the response units.

In the training situation itself, availability of the prescribed responses is maximized by overt performance and rehearsal of these responses. Hence, a training procedure which requires the learner to practice or recite responses is likely to be more effective than one calling upon him merely to observe the material. This conclusion is supported by the results of an experimental study of audiovisual training procedures conducted with army personnel during World War II (1). In this study a sound film was used to teach the phonetic alphabet to groups of Signal Corps men. The phonetic names corresponding to each letter were presented by a narrator. Review lists were interspersed periodically among the presentations. The critical experimental variable was the procedure used during the review periods. For the standard group, the narrator summarized the items that had been presented. The experimental group was required to recall and recite the appropriate names in response to each of the letters. A proficiency test showed that the experimental group had learned significantly more than the control group. The difference was especially pronounced for difficult items, and among individuals whose initial ability was low. Active recitation may, of course, influence factors other than response availability. For example, subjects whose performance is tested periodically may be more highly motivated than those who are merely required to observe. In any case, overt performance of the correct response is considerably more effective than passive observation.

Given available responses, what determines the speed of associative learning—the duration of the second stage of acquisition? The evidence strongly suggests that the pre-experimental associations of the stimulus and response terms are one major factor. The more diversified the associative contexts which have accrued to the items prior to the experiment, the more likely it is that the desired stimulus-response connections (a) have some initial strength which can be built up through reinforcement, or (b) can be established readily through mediational links. Meaningfulness in the sense of different associations elicited by an item has repeatedly been shown to be significantly related to the speed of learning. It must be recognized, however, that pre-experimental associations not only may facilitate the acquisition of new habits, but also may be a source of interference when the new associations are incompatible with well-established old ones.

When the learning task comprises more than one associative connection, the degree of similarity among the stimuli and responses is an important determinant of the speed of learning. Consider stimulus similarity first. The performance of the task requires that the stimuli be discriminated from each other so that each response is given to its appropriate cue. To the extent that there is failure of discrimination, errors of generalization will occur: similar stimuli will tend to elicit the same response. Mastery of the task will be delayed until the stimuli have been differentiated, and errors of generalization have been eliminated. It is a fact that the difficulty of the learning task increases with stimulus similarly whether in formal properties—overlap in letters or phonemes, structural characteristics of visual stimuli, etc.—or in semantic properties. To help promote learning efficiency, stimulus similarity should, therefore, be minimized as far as is consistent with the objectives of training.

The effects of response similarity on learning are more complex than those of stimulus similarity. To the extent that the responses have common components or overlap in meaning, there is a systematic reduction in the total repertoire of responses which must be available for mastery of the task. The greater the reduction in the total repertoire, the less response learning is required for a task of given length. In that sense, response similarity facilitates learning. However, as the class of responses becomes more restricted, increasingly fine discriminations are required among the members of the class, and the associative stage of learning becomes accordingly more difficult. As may

be expected, the frequency of misplaced responses increases as a function of response similarity. The net effect on learning depends on the balance of facilitative and inhibitory effects, and may be expected to be smaller than that of stimulus similarity which has strictly negative influence.

In summary, the availability of responses, the associative contexts of the stimuli and responses, and the degree of similarity among stimuli and among responses are major determinants of the speed of acquisition. Careful manipulation of these variables may prove to be valuable in the development of effective procedures of audiovisual training.

Transfer of Training.

Transfer effects may be either positive or negative; that is, earlier learning may facilitate or inhibit the acquisition of new habits. The sign and magnitude of the transfer effects are determined by the relationships among the stimuli and responses in successive tasks. An old and frequently cited generalization is that the attaching of an old response to a new stimulus is a condition of positive transfer, whereas negative transfer must be expected when a new response is to be learned to an old stimulus. This rule refers to two limiting cases which may be subsumed under more general principles of transfer. These principles are (a) that the magnitude of the transfer effects increases as a function of the similarity of the stimuli, and (b) that the degree to which the effects are positive or negative depends on the relationship between the responses required in successive tasks. As the relationship between the responses changes from identity—through decreasing amounts of similarity—to incompatibility, the transfer effects become more and more negative. As our point of reference, let us cite continuous practice on an unchanged task. Here stimuli and responses are identical, and the positive transfer effects between consecutive stages of training are maximal. Now, with the stimuli unchanged, let new but similar responses be substituted. What will be the transfer effects here? Since the response similarity produces conditions of both facilitation and competition—as we earlier showed—the balance between these two influences determines whether and to what extent the net transfer is positive or negative. As the two systems of responses become unrelated and incompatible, negative transfer effects begin to predominate. All transfer effects, whatever

their characteristic increase directly with stimulus similarity: earlier learned responses can facilitate or inhibit performance only to the extent that they continue to be elicited in the new situation.

As we emphasized earlier, the terms stimulus and response are used in a descriptive sense to refer to manipulable conditions and delimited segments of behavior, respectively. In principle, the analysis sketched above can be applied to the transfer of methods, modes of attack and attitudes from one problem situation to another. It must be pointed out, however, that in controlled experiments important transfer effects are observed for which it is difficult to specify the underlying stimulus-response relationships. One example of practical as well as theoretical interest is the phenomenon of "learning to learn." When an individual practices a series of tasks of the same general nature—when, for example, he learns a number of verbal lists, or solves a number of discrimination problems—the efficiency of his performance increases considerably and often quite rapidly. Such improvement occurs even when there is no opportunity for the transfer of specific responses from one task to the next, and indeed, may appear even when there is interference among the responses. Clearly the transfer effects reflect the acquisition of modes of attack, the avoidance of certain types of errors, and other general adjustments to the learning situation. Thus far, there has been only very limited progress in the analysis of the classes of habits which constitute learning how to learn. It is essential, however, in the design and evaluation of specific training procedures to take account of the progressive development of learning skills.

The principles of transfer have obvious implications for the development of effective programs of instruction. (a) The training tasks should be designed to maximize positive transfer from earlier habits. The old habits on which the teacher can build include not only specific stimulus-response associations, but also general methods of practice and modes of attack. The teacher must also take into account the possibilities of negative transfer from prior habits. It is often useful to bring the error tendencies out into the open so that they may be unlearned and correct responses substituted. (b) The methods of instruction should also be designed to maximize the probability of positive transfer from the classroom to new situations. The more similar the training situation is to the conditions of later application, the higher is this probability. Here audiovisual techniques can be used effec-

tively during the period of instruction to simulate realistic conditions of performance. In the light of the preceding analysis, it is clear that careful attention should be given to the relationship between the specific responses practiced during training and those required outside the classroom. It is especially important to consider how readily symbolic responses are translated into action.

Retention.

Perhaps the most important single criterion in the evaluation of training procedures is that of long-term retention. Successful training establishes habits which are not easily forgotten, and thus continue at effective strength long after the student has left the classroom. Important advances have been made in the experimental analysis of the conditions of forgetting, and some of the generalizations which have been emerging promise to have important practical implications. One theoretical position which is strongly supported by extensive experimental evidence—the interference theory—considers forgetting as a special case of negative transfer. That is, forgetting is not simply a matter of the passage of time. A habit is forgotten when other habits learned earlier or later successfully compete with it and thus interfere with its performance. The conditions which produce negative transfer in acquisition—similar stimuli and incompatible responses—are also conducive to response competition in recall, and hence to retention loss.

When habits acquired earlier interfere with the retention of a given task, we call that interference proactive inhibition. Retroactive inhibition occurs when the interference is produced by new learning which occurs between the end of practice on a given task and the test of retention. Both types of interference can be readily demonstrated in the laboratory. We assume that the same mechanisms are responsible for forgetting outside the laboratory. In the case of verbal materials, for example, the subject's language habits are powerful sources of interference when newly learned associations are inconsistent with common linguistic usage. In general, proactive interferences will play a larger role in determining the course of forgetting than will retroactive interferences. The habits the individual has established before he comes to the laboratory or the classroom are likely to be more numerous and stronger than those he acquires between the end of training and the time of recall. Thus, a prediction of long-term retention must take account of the cumulative products of earlier learning which can become sources

of interference even if they are temporarily replaced by new habits under the controlled conditions of training. The more we can build on well-established habits in the mastery of new tasks, the better are the prospects for the long-term retention of these new tasks.

The most effective method of insuring the long-term retention of a habit is to carry original learning to a high degree of strength. Whatever the amount of interference, a strongly learned habit will be more resistant to it than a weakly learned one. Overlearning—continuation of practice beyond the point of mastery—is beneficial because it builds up resistance to interference, especially when new responses are to be substituted for old ones. In considering the degree of learning required for effective retention, it is important to bear in mind that retention may manifest itself, and hence may be measured, in different ways. One of the basic distinctions is that between recognition and recall. Recognition depends on the ability to discriminate between correct and incorrect instances, between the familiar and unfamiliar. Recall requires the active reproduction of a learned response. Recognition requires a lower degree of habit strength than does recall; after a given amount of training, the accuracy of recognition declines more slowly than does the ability to recall. Thus, the optimal degree of learning, or overlearning, depends on the way in which long-term retention is to be evaluated.

CONCLUSION

We have presented some of the general principles of acquisition, transfer and retention which are supported by experimental research on human learning. As we suggested in the introduction to this paper, it is a reasonable working assumption that these principles apply to audiovisual instruction just as they do to the controlled procedures of the laboratory. On this assumption, the analysis of the process of audiovisual education does not call for the formulation of special principles; it calls for the application and elaboration of the general laws of human learning.

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Comment and Summary: A Mine of Possible Applications

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THERE ARE FEW TOPICS about which any considerable number of psychologists appear to agree, and no topic is more likely to produce disagreement than learning. A superficial reading of the contributions presented here gives the impression of the babble of voices one has come to expect among psychologists. A careful reading of these papers, however, reveals that there is not so much disagreement or contradiction as there are differences in emphasis.

Psychologists and schools of psychologists find different things to be important. Thus, some synthesis is possible. Indeed, when viewed this way, the papers presented here provide an astonishing richness of ideas, ideas that succeed in looking at the problem of audiovisual aids from just about every conceivable angle. In the comment and summary that follows, I shall attempt to compare the different ways of looking at the problem as presented by the various contributors.

Development of Understanding

Luchins is a Gestalist among Gestalists. He draws heavily upon the ideas of Wertheimer. Like Wertheimer, he thinks that there are elegant ways of learning and stupid, blind ways. He emphasizes processes in learning. He reminds us that the same outcomes (responses) may come about by very different processes and that some processes are better than others, better because they lead to general principles, to transfer and to understanding. Other processes are rote, stupid, and

blind. They lead to no general principles and do not contribute to understanding.

In this connection, Luchins makes a point not explicitly made by the others, save perhaps Glaser. Luchins' point can be paraphrased by saying that not all mistakes are bad; some are less bad than others and, indeed, may even be good. A good mistake is one which, while it shows the person to be wrong in some detail, also shows that he has achieved some understanding. There is a comparison here to the notion Glaser states about auxiliary responses during programed training.

Luchins discusses motivation, but he begs the question about the basic issues he discusses. He does say that audiovisual devices provide good motivation to the extent that they depend upon the structural features of the subject matter. Reliance on extrinsic motivation is bad, partly, I suppose, because the answer to the question, "Why am I learning this?" is part of the understanding of what is being learned. The answer to that question, when extrinsic motivation is relied upon, is the mechanical, irrelevant answer, "Because you must," or something similar. Luchins doesn't say so in so many words, but I infer he would support the idea that there are cognitive drives which can be directly satisfied by learning. Perhaps it is the aim of audiovisual devices both to arouse and to satisfy such drives.

Luchins wants to be sure that audiovisual devices do not stress responses (outcomes) at the expense of producing the wrong kind of processes (misunderstanding). But it is probably here—in the promotion of understanding—that audiovisual devices find their greatest use, since they enable students to see a working of an entire system, or to view at firsthand the kinds of things they would otherwise only know by verbal description. Perhaps Luchins would want us to provide some means of testing for understanding in connection with audiovisual material.

It is no surprise that Luchins treats interference in the light of the *Einstellung* effect. Here again, his emphasis is upon understanding and the resistance of understanding to interference. Needless to say, Luchins finds practice to be a less critical condition than what happens when an individual is set to the task of learning. Indeed, from his own research, Luchins reminds us that repetitious drill may be responsible for negative *Einstellung* effects. To avoid the *Einstellung* effect, Luchins tells us, variety rather than repetitious drill is required in the early levels of a skill. Practice, even though it may refine skilled performance, brings

the danger of narrowing the person's outlook.

It would be interesting to see how the traditional interference theory would regard Luchins' suggestions about practice. Is there the making of a controversy here? At any rate, here is an important experimental issue for the study of learning in the classroom.

Motivation and Communication

McDonald sticks closely to his chosen topic of motivation and the communication process. He reminds us that audiovisual devices may be highly motivating without guaranteeing that the right kind of learning will take place as the result. He also reminds us that the available literature on the motivating ability of audiovisual devices is not too encouraging, but he is quick to point out that this may be because criteria of performance were chosen which emphasized learning rather than interest. Here McDonald makes an important point for research in audiovisual devices. Attempts to assess the motivating properties of any classroom technique may and should be examined independently of the criteria of learning. A given technique or presentation may be highly arousing without producing specific measurable changes in the direction of some criterion (the test of learning).

McDonald thinks highly of the possibility of audiovisual devices, not as specific instructional tools (which they may be also), but as methods of stimulating interest in tasks, and for selecting relevant aspects of tasks to which to attend. In this connection, McDonald might have mentioned the large and important experimental literature on stimulus predifferentiation. Indeed, it may be some process such as stimulus predifferentiation (causing persons to attend to relevant stimulus dimensions) that functionally distinguishes true audiovisual *aids* from direct instructional techniques (such as the teaching machines).

McDonald also mentions the possible interaction between the orienting effects of audiovisual devices and personality characteristics. This, it seems to me, is an important point, both in the negative and positive direction. Let me mention a negative case. I have rejected many otherwise worthy instructional films for my own courses because these films arouse hostility and rejection in my rather worldly and sophisticated students. They resent being talked down to, and would find many films condescending. Interactions between social and personal characteristics of pupils and films can work the other way too, of course. The point is that we need to know more about the pre-exposure

attitudes and characteristics of target populations, and we need more information describing the kinds of reactions different groups give to particular materials. Perhaps we should require each particular film or device to be accompanied by normative information, much as we now require rather careful and explicit normative information to accompany the standardized tests we use.

Finally, let me mention one point McDonald makes with which I mildly disagree. He says that the teacher is in fact an audiovisual device. Indeed she is, but not quite in the same way as a film or a tape. Teachers vary endlessly one from another, and the same teacher will behave very differently from occasion to occasion. The important characteristic of a film, however, is that it is ever the same. Thus, it is possible to obtained standardized information about the effectiveness of a film in quite a different sense than it is possible to obtain information about the effectiveness of any given teacher. The audiovisual device, therefore, lends itself to experimental research and useful information of a normative kind far more readily than does the individual classroom teacher.

Application of Current Findings

Glaser is full of the exciting new technology of learning, and he gives us the advantage of his considerable experience in that subject. He tells us that the application of current theories of learning will be less fruitful than the application of current findings. With this belief I am inclined to agree. There is, however, a healthy middle ground where many theories agree, and these are in important areas about which we have some solid facts. What is more, theories of learning conflict with one another less than they used to, perhaps because they are now more specialized. Each takes a particular set of problems as its province, and there is a feeling that disagreement is now more about what it is important to study than about conflicting applications of theories for the whole area of learning.

Glaser emphasizes response. Here is superficial disagreement with Luchins. But this is, I think, a disagreement of emphasis rather than substance. Luchins is interested in process and what one can infer about process, and he gives only superficial attention to the responses one uses in making such inferences. Glaser, however, is cautiously aware of the fact that any inferences we make about how, what, and why someone learns comes only from his behavior. Thus, Glaser says

we must be very careful to shape the right responses. He believes that if you shape the right responses, processes will take care of themselves. Perhaps this is going too far, but the point is worth mentioning.

Task Analysis for Films

Glaser reminds us that when experimental psychologists turned to training research in the military, "task analysis" had to be invented. Behavior theories, much less theories of mind, did not provide us with analytic schemes for specifying what was important to train in various tasks. Glaser implies that much research on audiovisual aids—outside of the military and industrial settings—has suffered from a lack of task analysis. How many educational theories, much less theories of classroom learning, have precisely and analytically stated the specific requirements of the task they wish to teach? This lack, supplied in some areas such as arithmetic has, perforce, been supplied by the nature of the task itself. But how many makers of films on general science or human geography have, without illusion, asked themselves what their films are supposed to do? Perhaps a task analysis, like normative information for tests, ought to be a requirement for each film.

Glaser's distinction between initial responses, auxiliary responses, and terminal responses is important. It is very like a point Luchins made from an entirely different point of view. These sections of Luchins' and Glaser's papers are worthy of careful, comparative scrutiny. Glaser, further, gives us some general principles. These are derived, I'm sure, from his experiences in programed learning, and they spell out the steps in "shaping" behavior (to use again the phrase invented and popularized by Skinner).

Reinforcement and AV Devices

Perhaps we may borrow some of Luchins' doubts in making comments about Glaser's applications of reinforcement schedules to audiovisual devices. Perhaps it is not the specific response we reinforce that we wish an individual to learn. Perhaps we wish him to learn something far more general, something that can only be achieved by learning many different things. High and stable response rates for any one response may not be desirable. Indeed, this may be the "rote" learning of multiplication tables and the like that was the fearsome dragon slain by the new scientific education some 60 years ago. Glaser, of course, is aware of this problem, and he treats of it knowingly in his section

on reasoning and understanding. He gives a central position to Skinner's quote—(which brings Luchins-Wertheimer perilously close to Glaser-Skinner)—"An important goal is to 'enrich' the student's understanding by inducing him to permute and recombine the elements of his repertoire."

Glaser is less specific and less incisive when he comes to the discussion of motivation. By citing the studies of anxiety and learning, perhaps he intends to remind us that motivation is not necessarily good. Indeed, among those motives that are good, some are better than others, and they are better for many reasons, some of which are important for the tasks being trained. McDonald, it seems to me, is sounder on the issue of motivation.

For the study of any psychological problem we need a descriptive language which isolates the essential characteristics so that we may examine those aspects of behavior that are important and the variables that control them. For this purpose, Kendler reminds us that stimulus-response psychology has devised the most useful system. Though Luchins may not be willing to agree, I think even so Gestaltist a psychologist as he, must, in some analytic sense, reduce what he talks about to stimulus—the environment controlled by the investigator—and response—the outcome from which we draw inferences about processes.

Kendler, however, goes further than the use of stimulus-response language in the operational, empirical sense (though I think this is a most important sense to the topic under consideration). He obviously wants us to apply the stimulus-response analysis to inferences about psychological processes. He reminds us of what every sophisticated stimulus-response theorist knows: behavior itself does not consist of stimuli and responses, but rather our analysis of it does. We represent behavior conceptually as stimuli and as responses. The value of stimulus-response psychology is its ability to reconstruct an approximation to behavior as it occurs in nature.

Kendler passes over the direct contributions of stimulus-response theories of learning to educational problems and, wisely, chooses to consider in detail the implications of stimulus-response analysis for the strategy of research in educational problems and specifically audio-visual problems. In accomplishing his purpose, Kendler sketches out what he regards as the essential framework of stimulus-response analysis and how it applies to an educational situation.

In the main, Kendler's analysis is worth careful study. It is the most sophisticated account of its sort that I know about. He makes, however, what appear to me to be a few mistakes. These are mostly unimportant points, but there is one major one. He asserts that "the organism must make the correct response when the appropriate stimulus occurs *and* when necessary conditions for associative learning are available." I believe he implies an *overt* response here, and I hope he really doesn't intend this implication. For stimulus-response analysis demands only that we suppose a response to occur. What the nature of the response is may be specified by theory or it may be quite vague. In any case, it is only necessary to suppose some response (mediator), and to have an explicit way of working out a test of the outcomes of that response. We need not suppose, however, that for learning to take place an overt response must be made *at that time*.

One thing is clear. This is something that stimulus-response theorists have not yet emphasized enough in pointing out to educational psychologists the implications of their ideas for the study of education. This is the fact that, all things considered, a much easier control over the eventual outcome of learning is possible if all the responses made are overt and observable.

From this point we can aim an important criticism at Luchins. His ideas are appealing, but he gives us no precise way of specifying his central concept of understanding. Kendler would object to the concept, I suspect, on these grounds. I see no reason why the concept of understanding cannot be considered analytically by stimulus-response theories, particularly those of the mediation variety, such as Kendler himself has been working with the past few years. I think it very likely that the explicit working out required for this task would have fruitful results, particularly for the study of problems in education.

A Dimensional Approach

If the late John A. McGeoch had written a paper for this issue, I think he would have said very much what Postman has said. Postman is empirical but analytical. He wants us to examine the conditions which influence learning and performance as they are influenced by audio-visual devices, and he wants us to examine them analytically.

The concept of the analytic approach, which I think is Postman's theme, deserves comment. Very often, applied experimental studies are not analytic. This is particularly true of applied experimental

studies in education. The usual technique is to compare some conditions, frequently only two—an experimental and control condition—and these conditions differ from one another in ways which cannot be specified in any analytic dimensions. A dimensional approach, such as that espoused by McGeoch and championed here by Postman, would require us to find out the important aspects or ways in which tasks, skills, and conditions differ from one another, and then to examine each of these as a function of independent variables both singly and in combination.

This is much the same point that Glaser makes in his discussion of task analysis, though the concept of dimensional analysis carries with it much broader theoretical implications. Postman, I suspect, wants us to place the study of audiovisual devices on precisely the same footing as the study of theoretical issues in the psychology of learning.

A Motto for AV Research

Postman devotes much of his paper to a review of experimental problems in the psychology of learning that are relevant to educational issues, particularly those in the study of audiovisual devices. This is an extremely competent review, to which it would be extravagant for me to add. The reader is admonished, however, to read this section of Postman's paper with extreme care, since it is a highly condensed summary and contains a mine of possible applications. I wonder, for example, whether or not Underwood's notion of stage analysis of laboratory verbal learning, which Postman discusses, would have application to problems in classroom learning. As Postman implies, the stage analysis idea gives us, for the first time, a precise and theoretically sound way of dealing with the problem of recitation in learning.

In Postman's paper we also find a brief, up-to-date summary of the latest results in the interference theory of forgetting. Postman has contributed to this area himself, and he speaks more succinctly than anyone else could about the implications of current studies in retention and forgetting.

Postman's concluding sentence is worth quoting again, and I think it might well serve as a motto for research upon audiovisual devices. ". . . the analysis of the process of audiovisual education does not call for the formulation of special principles; it calls for the application and elaboration of the general laws of human learning." Certainly this is the assumption that has gone into much of the modern work on

teaching machines, and it is clear that the study of special films, illustrative material, and demonstrations deserves the same. I believe it likely that the next decade will show a fruition of the psychology of learning into the technology of learning. It is only fair to say that such a development should work both to the advantage of the pure study of learning and to the applied study of training programs and classroom learning.

Summary

In summary, then, what have the contributors said? They have impressed upon us the need for analytic, dimensional study of audiovisual devices. This recommendation comes especially from Glaser and Postman. To this recommendation Kendler would want to add: the analytic study should be theoretically oriented. In this latter recommendation, Luchins would probably concur, though his theory will be different, influenced as it is by Gestalt tradition and by his great concern for process. Luchins' concern is a well-placed one, and one of the signal contributions of Gestalt theory to the study of learning has always been its insistence on such concern. The kind of stimulus-response theory espoused by Kendler is also concerned with process, and a working together of stimulus-response mediation theory and Gestalt theory, it seems to me, is quite possible.

McDonald reminds us not to neglect the motivational properties of audiovisual devices. This, indeed, may be their specific function. Even when it cannot be demonstrated that they directly produce learning which is better, or more efficient, or more productive of understanding than learning by ordinary classroom procedures, they still may have an advantage in motivating interest and in providing something like stimulus predifferentiation.

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